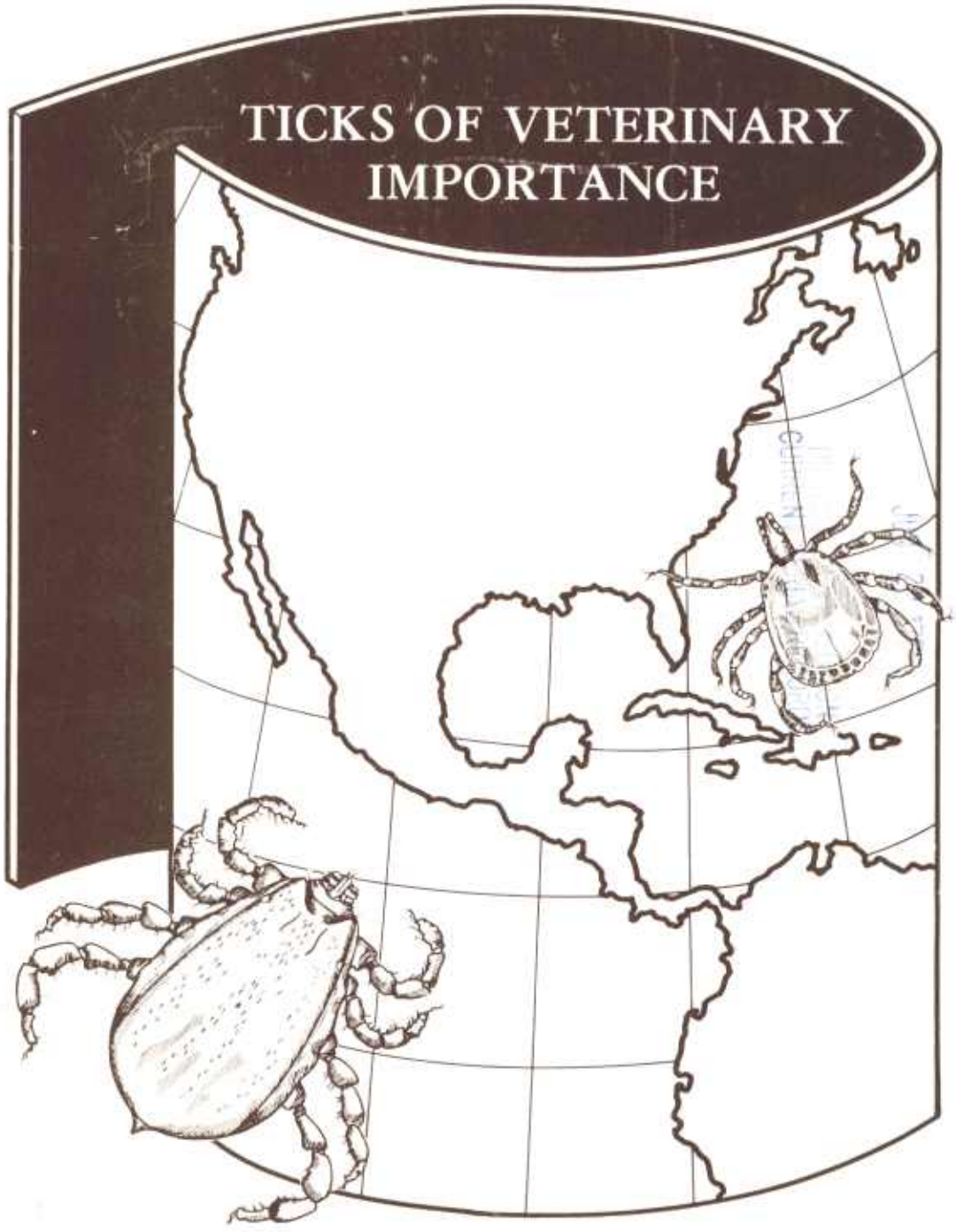
TICKS OF VETERINARY IMPORTANCE



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PREFACE

The primary purpose of this manual is to serve as a training aid and provide basic information on ticks and tick-borne diseases for veterinarians and animal health technicians directly or indirectly involved in tick surveillance, control, and eradication activities. It is not intended to be a definitive work on ticks of veterinary importance.

Veterinary Services is especially grateful to the many persons whose works have been consulted in the preparation of this manual. Without freely drawing on their publications, this manual could not have been compiled. Some of the principal contemporary researchers include Harry Hoogstraal, Jane Walker, Gertrud Theiler, C. N. Smith, E. C. Loomis, Glen Kohls, Carleton M. Clifford, W. O. Neitz, M. N. Kaiser, and P. R. Wilkinson. Earlier tick researchers include W. A. Hooker, F. C. Bishopp, H. P. Wood, W. D. Hunter, R. A. Cooley, and G. H. F. Nuttall.

A section on ticks, intended as the first part of a contemplated field manual on veterinary entomology for personnel of the Animal Disease Eradication Division, was initially compiled by Gerald Diamant, Robert K. Strickland, and the late W. G. Bruce. The section on ticks was issued in June 1961 and slightly revised in August 1961.

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CONTENTS

CONTENTS—Con.

CONTENTS—Con.

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS—Continued

TICKS OF VETERINARY IMPORTANCE

I. INTRODUCTION

The threat of the introduction of ticks and tick-borne diseases into the United States is probably as great today as at any time in our history. The United States is no longer protected by the dual barrier of time and space. Modern transportation has increased the chances of survival of ticks and other external parasites on animals in transit. Today it is possible to load animals on swift ocean vessels in Africa, Asia, and Europe, and in a few days have them unloaded at one of our ports of entry. With air transportation — and more animals are being shipped by air each year—departure to arrival is measured in hours rather than days.

In earlier days, during the long, slow voyages of sailing ships, the infected animals often died or recovered during the voyage so that upon arrival they were not often a threat to the domestic livestock. The ticks usually completed engorgement, dropped from the host, and were washed overboard before arrival at the port of entry.

Since the end of World War II, the importation of exotic animals by zoological gardens, animal dealers, and individuals has created a potentially dangerous situation. Too often these exotic animals are infested with economically important species of ticks. For example, some species found on animals at air, land, and ocean ports of entry and on animals already in zoological compounds include *Amblyomma hebraeum, A. pomposum, A. variegatum, Boophilus annulatus, B. decoloratus, B. microplus, Ixodes ricinus, Rhipicephalus appendiculatus, R. bursa, R. evertsi, R. simus, Hyalomma marginatum,* and *H. truncatum.* Many other species of equal or unknown economic importance have also been detected.

Ticks are of importance to man and his animals for two reasons: they are all parasitic and many are important transmitters of diseases to both man and lower animals. Ticks are the most important vectors of a variety of disease agents to domesticated animals and are second only to mosquitoes as transmitters of diseases to man. Ticks harbor protozoa, viruses, bacteria, rickettsia, and toxins, and transmit these organisms to man and animals.

Ticks are able to survive adverse conditions and transmit diseases for a number of reasons: they have a heavy, protective, chitinous covering; can withstand long periods of starvation; have a wide host range; deposit large numbers of eggs; are relatively free from natural enemies; and are tenacious bloodsuckers.

Ticks act not only as vectors but also serve as reservoirs of certain infectious agents. Mammals and birds are the principal hosts of ticks, but reptiles and even amphibians are parasitized by them.

Despite their lack of wings, ticks have become widely distributed throughout the world. This dispersion is attributed to the movement of their many hosts. About 10 percent of the approximately 800 known species of ticks are established in the United States. Of the 80 or so species found in the United States, about 20 are of some veterinary importance. A check list of the ticks found in the United States is included in the manual (see page 56).

II. TICK AND TICK-BORNE DISEASES

Since ticks are the most important vectors of disease agents affecting livestock, it is desirable to have some general knowledge of the diseases, the ticks which transmit them, and the geographical areas of the world where they are known to be established. This manual introduces some of the economically important ticks and tick-borne diseases, not only of the United States but also of other areas of the world. Detailed information on the diseases, tick

vectors, and distribution may be found in the published papers cited in the references.

The tick-borne diseases are usually recognized as being in one of the following groups: protozoal, rickettsial, bacterial, and viral. Ticks also produce tick paralysis, tick toxicosis, and serve as serious bloodsucking external pests.

PROTOZOAL DISEASES

Bovine Piroplasmosis

(Bovine Babesiosis, Cattle Tick Fever, Texas Fever, Redwater, Splenetic Fever)

In the New World bovine piroplasmosis, commonly called cattle fever, is produced by *Babesia bigemina* and *B. argentina*, protozoan parasites of the red blood cells. As the protozoans multiply they destroy the red blood corpuscles and thereby cause hemoglobinuria and anemia. This is accompanied by a rise in body temperature, depression, loss of appetite and body weight. The animal finally goes into a coma and dies. In severe outbreaks mortality may approach 90 percent. When ticks feed on an infected animal, the ingested protozoa pass into the reproductive organs of the female tick and thence into the eggs. Larvae, or seed ticks, emerging from these infected eggs thus become carriers and capable of transmitting the disease organisms to susceptible hosts. This is known as transovarian transmission — transmitting disease organisms from an infected female through the egg to the offspring.

Prior to the successful cattle fever tick eradication program, *Boophilus annulatus* and *B. microplus* were the most important external parasites of cattle in the United States. These were the only ticks involved in the transmission of bovine piroplasmosis in North America. An all-out eradication program was initiated by the U. S. Department of Agriculture in 1906. By 1943 the *Boophilus* ticks had been eradicated from the United States except for a narrow buffer zone along the Texas-Mexico border. This buffer zone was placed under Federal and State quarantine since reinfestations occur and an active surveillance and control program is required to prevent spread of *Boophilus* ticks into free areas.

Eradication is difficult because the cattle fever tick can withstand long periods of starvation—a single pair can produce several thousand offsprings in less than a year, and it parasitizes horses, mules, and deer as well as cattle.

In addition to *Babesia bigemina* and *B. argentina* there are three other species of *Babesia* affecting cattle throughout the world. These other *Babesia* are transmitted by one or more species of *Ixodes, Rhipicephalus,* and *Boophilus.*

Equine Piroplasmosis

This disease, also called horse tick fever or babesiosis, affects horses, mules, donkeys, and zebras. In horses the disease is characterized by fever, anemia, icterus, and often circulatory and respiratory distress. There are two recognized types of equine piroplasmosis.

In the United States the type of equine piroplasmosis most frequently encountered is caused by *Babesia caballi* and is known to be transmitted by *Dermacentor nitens.* Other ticks are involved in the transmission in other areas of the world. The distribution of *B. caballi* includes all or parts of southern Europe, Asia, Russia, Africa, West Indies, Central America, South America, and southern Florida.

The second type of equine piroplasmosis is produced by *Babesia equi (=Nuttallia equi)* and is regarded as being more pathogenic than the type caused by *B. caballi.* It has been reported from all or parts of southern Europe, Russia, Africa, South America and Asia, and southern Florida.

The tropical horse tick, *D. nitens,* is the only proven natural vector of *B. caballi* in the United States. It is also a suspected vector of *B. equi* in the West Indies and Florida. The only other tick presently established in the United States known to be capable of experimentally transmitting either type of equine piroplasmosis is *Rhipicephalus sanguineus.* Fortunately, *R. sanguineus* does not commonly feed on equines in the United States. Throughout the world several species of *Dermacentor, Hyalomma* and *Rhipicephalus* have been incriminated in the transmission of both types of equine piroplasmosis.

Canine Piroplasmosis

(Canine Babesiosis, Biliary Fever, Malignant Jaundice)

In the United States the brown dog tick, *Rhipicephalus sanguineus,* is the vector of canine piroplasmosis, caused by the protozoan *Babesia canis.* This tick is found throughout most of the world and is probably the most widely distributed of all species of ticks. It is well adapted to the climate of southern United States. The brown dog tick can pass its entire life cycle indoors, making it a very annoying pest in kennels and homes. Although it is basically a tropical or subtropical species and unable to survive outdoors throughout the winter in the northern States, the advent of central heating in homes and kennels has enabled this tick to become a common pest throughout the year as far north as Connecticut and New York.

Parasitization of the blood cells by *B. canis* causes fever, inappetance, incoordination, and anemia in affected canines. Dogs that recover may carry the organism in the blood for a year or more, eventually lose the infection, and become susceptible again.

The Theilerioses

There are several diseases caused by protozoal parasites of the genus *Theileria.* The organisms in the genus *Theileria* differ from *Babesia* in the following respects:

(1) They do not destroy the red blood cells, although they invade them during the acute phase of the disease.
(2) There is no multiplication of the organism in the red blood cells.
(3) Multiplication of the organism occurs in the lymphocytes and the endothelial cells of the lymph nodes, spleen, and liver.
(4) There is no transovarial transmission of the organism; transmission is stage to stage by 2-host and 3-host ticks.

The most important of the theilerioses is East Coast fever of cattle which is a serious problem in eastern and central Africa. This disease was once prevalent in South Africa, but reportedly it has now been eradicated. The causative agent is *Theileria parva* and the primary vector is *Rhipicephalus appendiculatus.* The mortality rate may be very high, often reaching 90 to 100 percent in susceptible animals.

In the Mediterranean coastal area and the Middle East a disease of cattle similar to East Coast fever is caused by *T. annulata.* Several species of *Hyalomma* ticks are involved in the transmission. The mortality varies from 10 to 90 percent, depending on the geographical area.

Two other species, *T. lawrencei* and *T. mutans,* are transmitted to cattle by several species of *Rhipicephalus* in parts of Africa. At least two species of *Theileria* have been reported from sheep and goats throughout the world. Benign strains of *Theileria* spp. have been reported from cattle and deer in the United States.

Bovine Anaplasmosis
(Gallsickness)

Anaplasmosis was long believed identical with bovine piroplasmosis. It was distinguished as a separate entity in 1910, when the disease and its anaplasma bodies were found in bovines free of cattle fever. The precise nature of the pathogenic organism that causes anaplasmosis is not known. Many scientists believe the organism is a protozoan, others theorize that it is a virus, or a rickettsia, or a microorganism belonging to a group of as yet unrecognized and unclassified biological position. This microorganism, *Anaplasma marginale,* multiplies in the red blood cells, and death of the host may result from severe anemia.

While not the sole mechanisms of spread, transmission studies have incriminated numerous species of ticks in the dissemination of anaplasmosis. *Anaplasma marginale,* like the causative agent of cattle fever, may be transmitted from one generation of ticks to the next. The suspected tick vectors of primary importance in this type of transmission in North America are the Rocky Mountain wood tick, *Dermacentor andersoni (=D. venustus), and B. microplus.*

Stage-to-stage transmission in the same generation has been recorded for the winter tick, *D. albipictus;* the American dog tick, *D. variabilis;* the black-legged tick, *Ixodes scapularis;* the brown dog tick, *Rhipicephalus sanguineus;* and the fowl tick, *Argas persicus.*

RICKETTSIAL AND RICKETTSIAL-LIKE DISEASES

Rocky Mountain Spotted Fever of Man

This disease, caused by an infection of *Rickettsia rickettsi,* is characterized by chills, high fever, pains in muscles and joints, and eruptions of livid spots on the skin. *Dermacentor andersoni,* the Rocky Mountain wood tick, is the principal vector in the mountainous regions of the Western United States and in the southern parts of British Columbia, Alberta, and Saskatchewan in Canada. The mortality may vary from 20 to 80 percent in untreated cases.

The Rocky Mountain wood tick is a 3–host tick and the life cycle is usually completed in 2 years. Small mammals serve as hosts for the larvae and nymphs. The adult ticks require large mammals, preferably cattle, horses, deer, and elk to complete their development. Man is an accidental host. Animals of intermediate size such as rabbits and badgers may serve as hosts for all three stages of the tick. The causative agent of Rocky Mountain spotted fever may be transferred by ticks via the egg to successive generations. The rickettsia is maintained in nature in a cycle between immature ticks and a variety of small wild mammals.

The American dog tick, *Dermacentor variabilis,* is responsible for the spread of Rocky Mountain spotted fever in Eastern United States, particularly Maryland, Virginia, and North Carolina.

Three additional species of ticks that are known to transmit Rocky Mountain spotted fever in the United States are *Amblyomma americanum, Haemaphysalis leporispalustris,* and *Dermacentor parumapertus.* Since the distribution of *A. americanum* lies within that of *Dermacentor variabilis,* the exact role of *A. americanum* as a vector of Rocky Mountain spotted fever in man is not known. The other two species, *H. leporispalustris* and *D. parumapertus,* are not found on man and are involved primarily as reservoirs and vectors of the disease in nature among wildlife, especially rabbits and hares.

Amblyomma cajennense and *Rhipicephalus sanguineus* have been reported as vectors of Rocky Mountain spotted fever in Mexico, but so far there is no evidence to incriminate them as vectors in the United States.

In southern Europe, Africa, and Asia, a related disease, boutonneuse fever (Marseilles fever, tick typhus), caused by *Rickettsia conori,* is often a problem in humans. Two important vectors include the cosmopolitan *Rhipicephalus sanguineus* and *Haemaphysalis leachi* of western, central and southern Africa. Other ticks have been incriminated in the transmission, and a variety of ticks and small mammals are involved in maintaining the infection in nature.

Q Fever
(Query Fever)

This ubiquitous disease, caused by *Coxiella burneti,* has been associated with many species of ticks. It is primarily a respiratory infection in man, and although it may be transmitted by the "bite" of an infected tick, transmission usually occurs as the result of the inhalation of dust or droplets contaminated directly or indirectly by infected cattle, sheep, and goats. Man may also be infected by the inhalation of the organism in dried tick feces or by the ingestion of contaminated milk. Infection is usually not apparent in livestock. The reservoirs in nature are ticks and a variety of small wild mammals.

Canine Ehrlichiosis
(Malignant Canine Rickettsiosis)

This is a septicemic disease of canines which is caused by *Ehrlichia canis* with *Rhipicephalus sanguineus* as the primary vector. The infective agent is transmitted by all three stages of the tick as well as through the egg to the next generation. Mortality rates as high as 90 percent have been reported. Canine ehrlichiosis has been reported from the United States, France, Africa, Syria, India, and the West Indies. It probably occurs in most areas which have established populations of *R. sanguineus.*

Bovine and Ovine Ehrlichiosis
(Benign Bovine and Ovine Rickettsiosis)

Cattle and sheep each have a benign form of ehrlichiosis caused respectively by *Ehrlichia bovis* and *E. ovina.* Bovine ehrlichiosis is common in South Africa where the vectors are *Hyalomma* spp. The disease has also been reported from the United States. Ovine ehrlichiosis

has been reported from Africa and Australia. In South Africa, *Rhipicephalus evertsi* is the vector; where as in north Africa (Tunisia and Algeria) the vector is *R. bursa.*

Heartwater

This rickettsial-like disease, caused by *Cowdria ruminantium,* affects sheep, goats, and cattle, but all ruminants may carry the causative agent, some without showing apparent clinical signs of disease. Heartwater has been observed in Africa for at least 100 years and its transmission by ticks has been known for some 70 years. The principal vectors are *Amblyomma hebraeum* in South Africa, *A. variegatum* in west, central, and east Africa; and *A. lepidum* in the Sudan. *Amblyomma gemma* and *A. pomposum* have also been incriminated. The disease agent is not transovarially transmitted. The ticks become infected during the larval and nymphal stages and transmit the causative agent during one of the subsequent stages.

Mortality in heartwater varies from 50 to 90 percent. Losses are highest in sheep, goats, and imported cattle. Persian and Africander sheep are more resistant, and mortality is approximately 6 percent.

BACTERIAL DISEASES

Tularemia
(Rabbit Fever)

Tularemia, primarily a disease of rabbits and rodents, is caused by *Francisella tularensis.* Man often acquires the disease by direct contact when dressing diseased rabbits but may also be infected by tick bites or by contact with infected tick feces. In addition to ticks, blood-sucking arthropods, such as the deer fly (*Chrysops* spp.), may be of importance in the spread of this disease. There are reports of serious outbreaks of tularemia in sheep pastured on land with heavy infestations of the Rocky Mountain wood tick, *Dermacentor andersoni.* In the United States, the principal vectors of the disease among rabbits and rodents, in nature, are several species of *Dermacentor,* and *Haemaphysalis leporispalustris.* Reportedly, *Amblyomma americanum* transmits tularemia to hunting dogs in Arkansas.

Man and domestic animals are not involved in the natural disease cycle of tularemia and become infected only when they accidentally enter into it. The mortality in man is approximately 6 percent.

Spirochetosis of Livestock and Poultry

In South Africa, spirochetosis has been reported from cattle, sheep, goats, and horses. The causal agent, *Borrelia theileri,* is transovarially transmitted by *Boophilus decoloratus* and *Rhipicephalus evertsi,* and produces a mild febrile disease.

Avian spirochetosis is a highly fatal disease of turkeys, pheasants, doves, and pigeons, and is reported in many countries throughout the world, including the United States. Transmission of the infective agent, *Borrelia anserina* is by several soft ticks of the genus *Argas.*

The Relapsing Fevers of Man

In the United States, tick-borne relapsing fever of man is transmitted by at least four species of soft ticks of the genus *Ornithodoros.* The disease is reported in limited areas of 13 Southwestern and Western States. There are several species of *Borrelia* involved and apparently each tick carries its own species or strain of the organism.

Like other species of *Borrelia,* the spirochetes are transmitted through the egg to the larval tick. Reservoirs of the disease include the rodent hosts and *Ornithodoros* ticks. Reportedly the *Borrelia* may remain infective in starved ticks for as long as 5 years.

Man comes into contact with the disease when frequenting caves and other areas where the ticks and their rodent hosts live. Transmission is affected by the "bite" of some species of *Ornithodoros* or by the contamination of the wound or skin with tick excretions in other species. The mortality is generally 5 percent or less, except in very young, old, or debilitated persons.

There are also endemic foci of tick-borne relapsing fevers reported from Mexico, Central America, South America, Europe, Asia, and Africa. In Africa, which probably has one of the highest incidences of tick-borne relapsing fever, *Ornithodoros moubata* is the primary

vector. This tick usually feeds at night and remains hidden during the day in the earth walls and floors of native houses. It is often detected by the presence of excreta marks on the outside of cracks and crevices in the mud walls.

Brucellosis

Although ticks are not known to be involved in the epidemiology of brucellosis in the United States, there are reports incriminating them as possible vectors and reservoirs of brucellosis in livestock in other areas of the world. In Russia, several species of ticks have reportedly been found naturally infected as well as being experimentally infected with *Brucella abortus* and *B. melitensis*. In Mexico, Tovar reports finding *Boophilus annulatus* naturally infected with *Brucella abortus;* he was also successful in experimentally transmitting *Brucella* by allowing infected ticks to feed on normal guinea pigs. However, until the importance of ticks as vectors of brucellosis is clarified, care should be taken in assigning them a definite role in the epidemiology of this disease. Ticks may play little, if any, role in the maintenance and transmission of brucellosis in the United States.

VIRAL DISEASES

Nairobi Sheep Disease

Nairobi sheep disease is an infectious, noncontagious viral disease of sheep and goats in eastern and central Africa. The primary vector is *Rhipicephalus appendiculatus,* but *Amblyomma variegatum* and several other species of *Rhipicephalus* are also involved in the transmission of the disease. Transovarial transmission is known to occur in *R. appendiculatus;* reportedly the virus can survive for about 2½ years in the adult stage of the tick. Mortality is invariably high in the native Masai sheep although it rarely exceeds 40 percent in Merinos or Merino crosses.

Louping Ill

Louping ill is a tick-borne virus disease of sheep transmitted by *Ixodes ricinus.* The disease is characterized by fever, nervous signs, ataxia, and paralysis. Cattle are occasionally infected; horses, pigs, and man are suspectible to a lesser extent. The disease is reported from Great Britain and Ireland. Mortality in sheep averages about 10 percent on farms where the disease recurs from year to year, but may be very high in sheep flocks encountering the disease for the first time.

Colorado Tick Fever

This is the most common human tick-borne disease in western United States. It is characterized by a sudden onset, aching in the muscles, headache, malaise, chills, a diphasic fever, and a marked leucopenia. There is usually an absence of the rash commonly associated with Rocky Mountain spotted fever. Although temporarily incapacitating, the rate of recovery is usually very high.

The primary vector of the virus of Colorado tick fever is *Dermacentor andersoni.* Other ticks found naturally infected are *D. occidentalis, D. parumapertus, Otobius lagophilus,* and *Haemaphysalis leporispalustris.* Small mammals and immature ticks, especially *D. andersoni,* maintain a reservoir of infection in nature.

III. TICK PARALYSIS AND TOXICOSIS

Tick Paralysis

Man, domesticated animals, and birds are subject to tick paralysis in North America, Europe, Africa, and Australia. While the true nature of the casual agents is not known, they act like neurotoxins producing an ascending paralysis that usually leads to incoordination and collapse within 4 to 7 days of attachment and feeding of the tick. In many instances, the symptoms subside if ticks are removed from animals before paralysis has progressed too far. If the ticks are not removed, the infested

man or animal dies. Studies with these toxins indicate that they cannot be transferred from affected animals to healthy ones. Although tick paralysis is primarily produced by the engorging females, the immatures of *Ixodes holocyclus* and *Argas persicus* can also produce paralysis.

The tick most frequently involved in tick paralysis in North America is the Rocky Mountain wood tick, *Dermacentor andersoni.* Serious livestock losses have been reported from western Montana, Idaho, Oregon, and British Columbia. Most human cases are in children under 7 years of age, and a mortality rate of about 12 percent has been reported. In the Eastern and Southern United States *Dermacentor variabilis, Amblyomma americanum,* and *A. maculatum* also produce tick paralysis in man and dogs. Infestation with only one tick may produce paralysis in a sheep, dog, or human. Infestation with many ticks is usually required to produce paralysis in cattle—which seem more resistant. In South Africa, *Ixodes rubicundus* produces a type of tick paralysis very similar to the paralysis produced by *Dermacentor andersoni* in North America. Australian tick paralysis is produced by *I. holocyclus.*

Tick Toxicosis

There are several forms of tick-borne toxicosis which are distinct from tick paralysis. Evidence indicates that these conditions are caused by toxins produced by some species or strains of ticks. As with tick paralysis, the tick-borne toxicoses cannot be transmitted by contact with affected animals, nor can they be transmitted by blood inoculations from affected to susceptible animals.

Sweating sickness is one of these toxicoses, and it differs from the others in that it is the only one in which the affected animals exhibit a profuse, moist eczema and hyperemia of the visible mucous membranes. This is primarily a disease of calves less than a year old. Mortality varies from 30 to 70 percent. The tick involved in Africa is *Hyalomma truncatum.* The clinical disease has also been reported from southern India and Ceylon.

In South Africa, another distinct tick toxicosis, which is caused by a leukocytropic toxin, is conveyed by *Rhipicephalus appendiculatus.* At least two other mild, non-fatal toxicoses of cattle, sheep, and pigs have also been observed in Africa. In Australia, very heavy infestations of *Boophilus microplus* on cattle were reportedly capable of producing clinical signs and pathological changes suggestive of tick-borne toxicosis.

IV. TICKS AS PESTS

As well as acting as vectors of disease-producing organisms, ticks may cause considerable mechanical injury, producing wounds susceptible to secondary bacterial invasion or screwworm infestation. Ticks also devour large quantities of blood. Severe infestations can cause anemia, loss of weight, and even death. Other losses on domestic animals, attributable to heavy infestations of ticks, include those caused by "tick worry" and hide damage.

Undoubtedly, the classic example of heavy tick infestation was reported in 1911 from South Africa where Sir Arnold Theiler, the distinguished veterinarian, collected half the *Boophilus decoloratus* from a horse which had died of acute anemia; the ticks removed from the horse weighed 14 pounds.

V. CLASSIFICATION AND DESCRIPTION OF TICKS

Ticks belong to the class Arachnida and are related to scorpions and spiders. Ticks and mites belong to the order Acarina and are closely related. The order includes two families of ticks: the hard ticks, Ixodidae, which have a scutum; and the so-called soft ticks, Argasidae, which lack a scutum (see classification chart page 91). Ticks are not insects.

Ticks are differentiated from adult insects by certain well-defined characteristics. The adult insect has three body segments:

- Head with eyes and antennae.
- Thorax with six legs, two pairs of spiracles, and usually one or two pairs of wings.
- Abdomen with genitalia and usually eight pairs of spiracles.

Ticks are small, wingless, bloodsucking parasites that have:

- Fused head and thorax.
- Eyes, when present, small and simple.
- Mouth parts set off from the body as a false head or capitulum consisting of a characteristic hypostome armed with longitudinal rows of recurved "teeth" or denticles, highly specialized chelicerae with apical cutting digits, and palps; but no antennae or mandibles.
- Body wall of argasids leathery. In ixodids, a hard chitinized shield (scutum) covers the back of the male; in the female, nymph, and larva, only a small shield is present dorsally behind the capitulum, the rest of the body wall being extensible, allowing the tick to enlarge greatly during feeding.
- Adults and nymphs with eight legs; larvae or seed ticks with six legs.

CLASSIFICATION OF TICKS

Phylum	Class	Order	Suborder	Family	Genus	Species	Common Name
Arthropoda	Arachnida	Acarina	Ixodides	Ixodidae (hard ticks)	*Ixodes*	*pacificus*	California black-legged tick.
						scapularis	black-legged tick.
					Haemaphysalis	*leporispalustris*	rabbit tick.
					Boophilus	*annulatus*	cattle fever tick.
						microplus	tropical cattle tick.
					Rhipicephalus	*evertsi*	red-legged tick.
						sanguineus	brown dog or Kennel tick
						appendiculatus	brown ear tick
					Amblyomma	*americanum*	Lone star tick.
						cajennense	Cayenne tick.
						hebraeum	bont tick.
						imitator	none.
						maculatum	Gulf Coast tick.
						variegatum	tropical bont tick.
					Dermacentor	*albipictus*	winter tick.
						andersoni (= venustus)	Rocky Mountain wood tick.
						nigrolineatus	brown winter tick.
						nitens	tropical horse tick.
						occidentalis	Pacific Coast tick.
						variabilis	American dog tick.
				Argasidae (soft ticks)	*Argas*	*persicus*	fowl tick.
					Otobius	*megnini*	spinose ear tick.
					Ornithodoros	*coriaceus*	pajaroello tick.
						talaje	none.
						turicata	relapsing fever tick.

VI. BIOLOGY AND BEHAVIOR

There are four stages in the life cycle of the tick: the egg, the 6-legged larva or seed tick, the 8-legged nymph, and the adult (male and female). Transition from one stage to the next is made by one or more moltings (shedding of the cuticle). The steps in tick development are not particularly restricted to seasons. Species adaptation, temperature, moisture, and availability of host animals influence their duration. The number of generations may vary from three or four a year in the 1–host species such as the tropical cattle tick, *Boophilus microplus*, to one a year in the Argasidae—or even one every 2 or 3 years in some 3-host species, such as the Rocky Mountain wood tick, *Dermacentor andersoni*.

Hard ticks are often referred to as being 1–, 2–, or 3–host ticks:

The 1–host ticks spend their entire developmental period, from young larvae to mature adults, on one animal. Example: The cattle fever tick, *Boophilus annulatus*.

The 2–host ticks attach as larvae and complete development through the nymphal stage. The replete nymph then drops from the host, molts to the adult stage, and later seeks a second host to complete development. Example: The red-legged tick, *Rhipicephalus evertsi*.

The 3–host tick feed to repletion as larvae on one animal, drop to the ground, and molt to the nymphal stage; as nymphs, attach to another animal and engorge, and again leave the animal to molt; and finally, as adults, feed on a third animal. Example: The American dog tick, *Dermacentor variabilis*.

The above designations do not usually apply to soft ticks since their feeding habits are quite different from those of the hard ticks. Soft ticks could be referred to as multihost ticks. Some soft ticks, such as *Ornithodoros coriaceus*, may have as many as seven nymphal stages with each stage feeding briefly. The female *Argas persicus* may feed as many as seven times and deposit a small batch of eggs following each feeding. Generally, the larval stage of soft ticks may attach and feed on the host for several days, but the nymph and adult normally feed for 30 minutes up to 2 hours, leave the host, and return to a protected area away from the host. The spinose ear tick, *Otobius megnini*, is an exception and could be called a 1–host tick.

Mating

Mating may take place on or off the host and during or after engorgement. With Argasidae, for example, copulation takes place after the adults have fed and left the host. With Ixodidae, copulation usually occurs on the host, after which the females appear to engorge more rapidly.

After mating and engorgement the female drops from the host and crawls to a protected place to oviposit. Under favorable climatic conditions, oviposition may begin within 2 days or, in cold weather, may be delayed for weeks or even months.

Oviposition and Incubation

The gravid female hard tick readies herself for egg-laying by bending the capitulum downwards so that it lies along the ventral surface of the body near the genital opening. A vesicle, the Gene's organ, is everted from between the basis capituli and scutum. The Gene's organ, which enlarges into two lobes, contains glands that secrete a waxy material. As the eggs are extruded from the genital aperture, they are received by these extended lobes and coated with the waxy secretion. This protects the eggs from dehydration and enables them to form an adherent mass.

While female hard ticks engorge only once and die shortly after the completion of oviposition, most soft tick females engorge a number of times and oviposit after each feeding. The number of eggs laid by ticks vary by species. For example, *Argas persicus* lays as many as seven batches of eggs; the number of eggs is usually 150 to 250 per batch up to the fourth batch but declines to less than half that number with the last two batches produced. On the other hand, *Boophilus microplus* lays a single batch of approximately 4,500 eggs. Although well above the average for hard ticks, one female *Amblyomma nuttalli* reportedly deposited 22,891 eggs in a single "sitting."

The incubation period is primarily determined by temperature. In the hard ticks this may range from about 2 weeks up to almost 7 months. In tropical or subtropical areas, the incubation period is usually relatively short and constant. However, in areas with a temperate climate, the incubation period may be only 2 or 3 weeks if the eggs are produced in the summer, or may be prolonged for many weeks or months if the eggs are layed in the autumn or early winter. For instance, the *Boophilus annulatus* female, which drops from the host in September, may deposit eggs which do not hatch until the following March.

Larva

Following hatching, the larvae, or seed ticks, usually remain clustered near the place of emergence. This is a protective measure to prevent desiccation and to insure survival. Larvae seldom feed within a week after hatching. When they are ready to feed they are often found awaiting a host upon blades of grass, small trees, or bushes. Upon the approach of a suitable host, the larvae are alerted by their sensory organs and become very active and attempt to crawl upon the animal. Larvae seem to be stimulated most strongly by carbon dioxide and odors, but vibrations, air currents, interrupted light, warmth, and moisture are factors which alert the tick to the presence of a host. Having found a host, the larvae may quickly seek out their favored site for attachment, or may wander over the host for several days before finding a suitable place to feed. Some species attach almost exclusively in the ear of the host; some prefer areas where the skin is comparatively thin; while others attach almost any place on the host.

The larvae feed, and when engorged, most species of hard ticks drop from the host to molt. They make their way to some protected area and become quiescent. Depending upon temperature and humidity, molting to the nymphal stage may take from 5 days to several weeks or longer. The engorged larvae of 1-host ticks remain on the host and molt after a short quiescent period.

Nymph

The activities and habits of nymphs are similar to those of the larvae, except that in most species nymphs tend to live longer. In those species that molt upon the host, molting takes place following engorgement and a short resting period. In those species that leave the host, the molt may occur within 2 weeks or may be delayed for several months. All hard ticks have only one nymphal stage, but all soft ticks undergo several nymphal molts, ranging from two to seven, with an average of three.

Adult

In those species that molt on the host, the adult female merely crawls from the nymphal skin and re-attaches at another site. The male sheds the nymphal skin, re-attaches and feeds for a short time, then seeks a mate.

The behavior of adults of those species that leave the host as nymphs to molt are similar to those of the larvae and nymphs, except that the unfed adult is usually capable of surviving much longer without a blood meal than either the nymph or larva.

Copulation of hard ticks usually occurs on the host; it generally precedes female engorgement and apparently influences the rapidity of its completion. Female hard ticks may engorge and drop within a few days of attachment or remain on the host for 30 days or longer. Apparently the females which remain attached for long periods fail to find mates. Males frequently remain upon the host much longer and thereby ensure ready mates for virgin females. In contrast, mating of soft ticks occurs away from the host—on the ground or in a protected area.

Feeding Habits

Ticks are obligatory parasites and require tissue fluids and blood for development. In feeding, most ticks attach to a preferred part of the host. Some favor the dewlap, shoulders, and the region between the legs. The tropical horse tick, *Dermacentor nitens*, prefers the ear but attaches to other parts of the body. The spinose ear tick, *Otobius megnini*, attaches only deep in the external ear. The red-legged tick, *Rhipicephalus evertsi*, feeds deep in the ear in its larval and nymphal stages and under the base of the tail or between the hind legs as an adult.

Ticks attach by cutting through the skin of the host with the digits of the chelicerae and anchor by inserting the hypostome into the wound. The rapidity of feeding varies considerably in different species and in different stages of the same species. Feeding in female hard ticks is usually a gradual process until the final day of feeding; then the body rapidly fills with blood. Most female hard ticks feed on the host for 7 to 12 days and under certain conditions longer—but rarely less than 5 days for complete engorgement. New cuticle is developed during the slow feeding in order to accommodate the large volume of blood ingested. Hard tick larvae and nymphs usually feed for shorter periods than females. Male hard ticks become only slightly distended; they are intermittent feeders and may remain on the host for weeks or even months, as with *Amblyomma variegatum,* during which time several small blood meals are taken.

The nymphal and adult stages of soft ticks normally complete engorgement within 30 minutes to 2 hours; whereas, the larval stage usually feeds for periods varying from 5 to 30 days.

During attachment and feeding, salivary secretions are injected into the wound, apparently to aid in penetrating the host's skin and in preventing the coagulation of blood and body fluids so that they can be readily ingested by the tick. The salivary secretions of some ticks are very irritating to the host. The pajaroello tick, *Ornithodoros coriaceus,* produces an especially painful "bite" which may remain inflammed for days.

From the standpoint of disease transmission and tick control, it is important to know that the immature stages of a particular tick species may not feed on the same host species as do the adults. For example, the adults of *Dermacentor variabilis* commonly attack livestock, man, and dogs; whereas, the immature ticks are almost always found on small rodents, especially mice.

Tick Secretions and Disease Transmission

Salivary secretions play a most important role in the transmission of disease by serving as a medium of transport for the causal agents. The disease agent is usually transmitted from the infected tick to the host via the salivary secretions.

Soft ticks have coxal organs, sometimes called coxal glands, which may have a role in the spread of pathogenic microorganisms by some species of soft ticks. The coxal organs open between the first and second pair of legs. Their function is to filter off excess liquids and salts from the blood meal soon after ingestion. Within 30 minutes, soft ticks may ingest a volume of blood which is several times the tick's original body weight. During feeding, the cuticle stretches to accommodate this large amount of fluid. The coxal organs enable the soft tick to rapidly reduce the total intake volume to a level which best suits its needs. In *Ornithodoros moubata* the coxal discharge begins about 15 minutes after the tick has begun to feed and may continue intermittently for about an hour after the completion of feeding. The spirochetes of relapsing fever pass from the infected tick in the coxal fluid on to the skin of the host. They may then penetrate the intact skin or enter the wound made by the tick. Some species of soft ticks do not excrete coxal fluid until after they have left the host. Hard ticks do not possess coxal organs.

Engorging ticks void excretory products which may contain pathogenic organisms that can enter the animal body through the tick-bite punctures or other breaks (or wounds) in the skin. The careless removal of ticks from the host may result in the rupture of the tick's body with the release of gut contents around the wound. Tularemia may be transmitted by both of these methods.

Tick-bite wounds predispose the host to infections and increase susceptibility to screwworm attack.

Longevity

Many species of ticks are able to survive for long periods without a blood meal. Nymphs usually live longer than larvae, and adults live longer than nymphs. The adult fowl tick has lived without food in vacant chicken houses for 37 months and then oviposited following a blood meal. The relapsing fever tick, *Ornithodoros turicata,* has lived more than 3 years in jars of sand. Unfed larvae of the red-legged

tick can survive for 7 months, and unfed adults for 14 months. The unfed adults of *Dermacentor variabilis* have been observed to survive up to 1,053 days under outdoor conditions in eastern United States. Under experimental conditions, the larval stage of *D. variabilis* may live more than a year without food; the nymphal stage was observed to live for 584 days without feeding. However, it should be emphasized that, in most of these extreme instances of long survival periods, these surviving ticks were not tested as to their ability to feed and to carry on to the next stage.

The longevity of some species may be greatly prolonged by reduced temperatures in the autumn and winter months of temperate regions. The activity of most, but not all, ticks is usually suspended during the cold months of the year. For example, *Boophilus annulatus* is inactive during the winter; on the other hand, *Dermacentor albipictus* is primarily active during this period and is commonly called the winter tick. There is considerable variation in the longevity of *Boophilus annulatus*, depending on the season of the year; unfed larvae survived as long as 246 days during cool weather but lived from only a few days up to 100 days during mid-summer.

Moisture is important in the longevity of hard ticks. Its complete absence is highly destructive. On the other hand, too much moisture, particularly following a long fasting period, permits the growth of fungi on ticks that is often fatal.

The longevity of any one or all stages in the life cycle of a species of tick must be taken into consideration when formulating a control or eradication scheme. Failure to do so may very well result in something less than control or eradication.

Instincts and Adaptations

Ticks are rigidly bound by instinctive behavioral patterns; nevertheless, they have made interesting adaptations for survival. Leaving one host to molt, with the necessity of waiting for a second or commonly a third host, results in high tick mortality. This hazard has been overcome to some extent in certain species of ticks by the development of one or more of the following: an increased resistance to heat or cold, the ability to withstand long periods of fasting, the capacity to produce an enormous number of eggs, and adaptation to a wide range of hosts.

All one–host ticks, such as *Boophilus* spp., *Dermacentor nitens,* and *D. albipictus,* have adapted themselves to molt on the host. The elimination of the need to seek a second and third host diminishes the threat of species-extinction in one–host species.

Ticks have also synchronized many of their activities with those of the host. Rabbits generally remain inactive in their nests during the day. The rabbit tick, *Haemaphysalis leporispalustris,* adjusted to the habits of its host by leaving the rabbit during the day. Thus, after hatching or molting, these ticks have little difficulty in finding the host when they are ready to attach. In addition, the larval and nymphal stages of the rabbit tick very successfully use several species of ground-inhabiting birds as hosts, while using rabbits as preferred hosts for the adult stage.

The engorged larvae of the fowl tick, *Argas persicus,* have made another adaptation for survival. They are globular in shape until a few hours before dropping; the larvae then flatten into the typical *Argas* form that permits them to crawl rapidly into protective crevices.

The nymphs and adults of *Argas persicus* are nocturnal in their feeding habits. To escape being devoured by chickens, they hide in cracks and crevices during the day, emerge at night to feed for 30 minutes to 2 hours on the birds, and return to their hiding places before the fowl become active.

Where ticks feed on the host is important in their survival. For example, the spinose ear tick and the tropical horse tick attach deep inside the ear. Species of *Haemaphysalis* found on quail, meadow larks, and ground-feeding birds customarily attach to the head, from which they are not readily dislodged.

Female hard ticks can speed up the final phase of engorgement. The female *Boophilus microplus* feeds leisurely, taking several days to become about one-third engorged. Then, within a few hours, she normally completes engorgement and drops from the host. Possibly this is a defensive mechanism to reduce the chance of the engorged female being crushed by the host or attacked by birds such as the oxpecker and cattle egret.

VII. CONTROL AND ERADICATION

Natural Control

The tremendous reproductive potential of ticks is mitigated by climate and by predators and parasites. Without these natural controls, tick populations build up to great numbers.

Temperature and moisture are principal agents affecting ticks. Cold weather, particularly prolonged cold, harms some species of ticks, mainly by killing them outright but also by prolonging their inactivity on the ground, where they are more prone to attack by predators. Excessive heat, dryness, or rainfall have an adverse effect on some species.

Wild birds, domestic fowl, rats, mice, ants, and at least two species of parasitic wasps play a part in the natural control of ticks.

Research and field observations of cattle indicate that purebred Brahman *(Bos indicus)* and Brahman crosses have a greater resistance to tick infestation than the European breeds *(Bos taurus)*. The mechanism of such resistance may not yet be fully understood, but the knowledge that some species or breeds are more resistant to tick infestation may be useful in contending with tick problems.

Pasture rotation may achieve control or eradication by starving the ticks. However, in view of the longevity of most species, pasture rotation without supplemental measures is seldom practicable.

Chemical Control

The most effective method of tick control is by the use of chemical pesticides. Since the usual method of tick dispersion is by movement of the host, pesticide control can be effectively used with quarantine and regulation of animal movements. The combination of pesticides and quarantine is essential in an eradication effort. Treatment of tick-infested premises, where extensive acreages are not involved, may also be included with other control measures.

Chemical control involves the use of pesticidal sprays, dips, dusts, aerosols, smears, or systemics. The use of systemics is a comparatively new approach to pest control. A systemic pesticide may be defined as a chemical which, when administered to an animal as a spray, dip, injection, bolus, drench, or feed additive, is absorbed into the body tissues, either in its original form or as a metabolite, and is toxic to susceptible parasites feeding on such tissues.

Most species of ticks can be effectively controlled by the proper use of pesticides. "Effectively controlled" here means the reduction of tick populations to the point where they are of little or no economic importance. It differs from eradication which results in the complete annihilation of a species from a defined geographical area—as with the cattle fever tick.

A large number of pesticides are effective against ticks. They include ronnel, crotoxyphos, coumaphos (Co-Ral®,) [1] dioxathion (Delnav®), toxaphene, malathion, and many others. The pesticide of choice will be determined by several factors, such as species of animal—cattle, horses, and swine—the type of animal—dairy or beef—and the cost of pesticide used. Consideration must be given to compliance with the Federal Food, Drug and Cosmetic Act which regulates pesticide residues in raw agricultural products, including meat and milk. If dipping is part of an official USDA Veterinary Services program, only those chemicals permitted by Veterinary Services may be used.

No attempt is made here to elaborate on the subject of pesticides and their uses. Instructions on vat management and the use of permitted pesticides for the control or eradication of ticks and insects of concern to Veterinary Services are issued as needed.

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[1] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee of warranty of the product by the U. S. Department of Agriculture or an endorsement by the Government over other products not mentioned.

VIII. REGULATIONS ON IMPORTING AND INTERSTATE MOVEMENT OF TICKS

The Animal and Plant Health Inspection Service of the United States Department of Agriculture has the responsibility for regulating the importation and interstate movement of animal disease-producing agents and animal disease vectors used in research of both human and animal diseases. It is essential that disease-producing agents and vectors, including all live ticks, are handled in a manner that does not endanger the health of domestic livestock and poultry.

The authority for regulating such movements is contained in Part 122 of Title 9, U. S. Code of Federal Regulations. The regulation states that no organisms or vectors of such organisms shall be imported into the United States or transported from one State or Territory or the District of Columbia to another State or Territory or the District of Columbia without a permit issued by the Secretary of Agriculture and in compliance with the terms thereof. As a condition of issuance of permits, the permittee shall agree in writing to observe the safeguards prescribed by the Department of Agriculture for public protection with respect to the particular importation or transportation.

Essentially then, anyone wishing to import live ticks or receive live ticks from another State must first obtain a permit from Veterinary Services. Ticks preserved in 70 percent alcohol or other preservatives are not subject to the regulations and, therefore, may be imported or moved interstate without a permit.

Individuals wishing to import or transport live ticks interstate or desiring additional information on the movement of disease organisms and vectors should direct their inquiry to:

Veterinary Services, APHIS
U. S. Department of Agriculture
Federal Building
Hyattsville, Maryland 20782

IX. IDENTIFICATION

The accurate identification of ticks is a prerequisite to their control and eradication. Identification is also essential to justify long, costly eradication programs, and the imposition of rigid quarantines.

Unfortunately there are not now, nor are there likely to be, simplified keys or procedures for the rapid creation of identification experts. The identification of the numerous species of ticks is a matter for the trained taxonomist. Nevertheless, Veterinary Services veterinarians and animal health technicians can become familiar with the biology and identification of the more common livestock ticks in the United States.

An explanation of all characters will be found on pages 16–20. Drawings of hypothetical ticks showing the location of key characters appear on pages 66–68.

X. THE KEY AND HOW TO USE IT

The key to the identification of ticks presents important characters of ticks arranged to facilitate identification. This key is for *adult ticks only* and primarily for ticks of veterinary interest in the United States.

It will be noted that the key is arranged in couplets, each couplet giving a choice of two alternate characters or two alternate groups of characters. Start with the first couplet and proceed to the couplet indicated by the number following the appropriate character, and so on, until the final determination is made. For example, place the specimen under the microscope topside (dorsum) up; focus the microscope and adjust the light on the tick. Have the drawing of a composite tick with parts labeled (pages 66–67) and the explanation of terms (pages 16–20) handy for ready reference.

Look at the first page of the key (page 20) and note that the first thing to determine is whether the specimen under the microscope is a hard tick (Ixodidae) or soft tick (Argasidae). Compare the characters in this couplet, then look at the tick. For discussion purposes, let us assume that the tick has a scutum (shield) and the capitulum (head) is at the anterior end of the body. Therefore, it is a hard tick (Ixodidae) and the reference is to page 21. Next, determine the developmental stage—larva, nymph, or adult (male and female). Remember, the keys in this manual are only for the identification of the adult stages.

Again, let us assume that the tick you have before you has eight legs and a genital aperture: it is an adult. Then, proceed to the key to the genera of adults of the family Ixodidae on page 21. Start with couplet 1. The important character here is the anal groove—is it in front of the anus, does it curve behind the anus, or is it absent? The specimen tick has a small groove behind the anus, so proceed as indicated to couplet 2. Here the choice is between a palpus with the second segment projecting conspicuously to the side or a palpus without such projection. The tick fits into the second category, so proceed to couplet 3. Here the choice is mainly between a hexagonal (six-sided) basis capituli or one not six-sided. The basis capituli on the specimen is rectangular, so proceed to couplet 7. Look at the palps under the microscope—are they short with the second segment not twice as long as its width? You immediately see that your specimen fits the first description, therefore you identify the tick as belonging to the genus *Dermacentor*. Now turn to page 24. Check the specimen with the "Morphological Characteristics of the Genus" under "GENUS DERMACENTOR." If they all fit, you can be certain you have keyed the specimen to the correct genus. Proceed now in the same manner through the key to the species of *Dermacentor* and you will identify the tick as *Dermacentor variabilis*.

Terms Used in the Key

Accessory shields:	Paired, projecting, sclerotized structures on venter, lateral to the adanal shields in males of *Boophilus, Rhipicephalus* and *Hyalomma.*
Adanal shields:	Paired, projecting, sclerotized structures on venter, lateral to the anus in males of *Boophilus, Rhipicephalus* and *Hyalomma.*
Anal groove:	Semicircular groove curving around the anus in some genera of Ixodidae (hard ticks); in *Ixodes* curving in front, in other genera curving behind or absent.
Anterior:	Toward the head end.
Anus:	Posterior opening of the alimentary tract, situated on the median line posterior to the last pair of legs.
Basis capituli:	Basal portion of capitulum on which the mouth parts are attached. May be of various shapes: hexagonal, rectangular, subrectangular or subtriangular in hard ticks and always attached to anterior of body. In soft ticks, located ventrally in adult and engorged nymph, anteriorly in larva.

Camerostome:	Cavity or depression in which the capitulum of soft ticks is situated. Usually not well-defined in engorged specimens.
Capitulum:	Anterior movable portion of body of hard ticks, including basis capituli, palps, hypostome, and chelicerae of hard ticks. Located ventrally in adult and engorged nymph of soft ticks, anteriorly in larvae.
Caudal process:	Distinct projection arising from median posterior end of the body in males of some species of *Boophilus, Rhipicephalus,* and *Margaropus.*
Cervical grooves:	Pair of grooves in the scutum extending posteriorly from the inner angles of the scapulae. May be continuous or interrupted, shallow or deep, faint or absent.
Cheeks:	Paired flaps at the sides of the camerostome in some species of soft ticks.
Chelicerae (sing. Chelicera):	Paired structures lying dorsally to hypostome which complete the cylindrical mouth parts that are inserted when the tick feeds.
Chitin:	The hard parts of the tick body formed from a colorless secretion produced by the epidermis.
Chitinized:	Filled in with or hardened by chitin.
Chitinous tubercles:	Small, chitinized, rounded lobes on the posterointernal angle of the festoons of *Amblyomma cajennense* and sometimes *A. maculatum.*
Cornu (pl. cornua):	Small projections extending from the dorsal, posterolateral angles of the basis capituli.
Coxae: (sing. Coxa)	Small, sclerotized plates on the venter representing the first segment of the leg to which the trochanters are movably attached. From anterior to posterior, the coxae are designated by Roman numerals I, II, III, and IV. Bifid coxae are those that are cleft, divided, or forked.
Coxal organs:	Called coxal glands by some authors and are present in members of the family Argasidae but absent in members of the family Ixodidae. The external openings of the coxal organs are located between coxae I and II.
Cuticule, or cuticula:	Outer covering of a tick. Also called the integument.
Denticles:	Small, recurved projections or "teeth" on the ventral side of the hypostome. (*See* dentition.)
Dentition:	Refers to the presence of denticles on the ventral side of the hypostome. The numerical arrangement of the files or rows of denticles is expressed by the dentition formula. Thus, dentition 3/3 means that there are three longitudinal rows of denticles on each side of the median line of the hypostome.
Dimorphism:	Difference in form, color, etc., between individuals of the same species, more particularly between sexes.
Distal:	Farthest from the point of attachment or origin.
Dorsal:	Pertaining to the back or top of the body.
Dorsal humps:	Protuberances on the dorsal surface of the segments of the legs, but not including the subapical dorsal protuberance.
Dorsal prolongation:	The posterodorsal extension of the spiracular plate.

Dorsum: The entire dorsal surface of the body.

Emargination: Anterior indentation or cutout place in the scutum between the scapulae that receives the basis capituli.

Engorged: Enlargement or distention of a tick following a blood meal. Since the scutum is short in the larva, nymph, and female hard tick (covering about half the dorsal surface in the unfed specimen), the body is capable of pronounced distention. As the body fills with blood, the relative size of the scutum is reduced. In a fully engorged female hard tick, the scutum may appear only as a small plate on the anterior of the body. In the soft tick, the scutum is absent and both sexes may become enlarged, although not usually to the extent of the engorged female hard tick.

Festoons: Uniform rectangular areas, separated by distinct grooves, located on the posterior margin of most genera of the hard ticks. Very distinct areas in unengorged specimens, but may not be visible in fully engorged females. In some species of *Hyalomma,* festoons may be reduced in number and partially coalesced. Festoons are not present in *Boophilus* and *Ixodes.*

Files: Longitudinal rows of denticles or "teeth" on the ventral surface of the hypostome.

Genital aperture: External opening of the genital organs. Located anteriorly on the ventromedian line, posterior to the basis capituli.

Goblets: Small, round structures located in the spiracular plate. They may be very small and numerous as in *Dermacentor variablis,* or relatively large and few was in *D. nitens.*

Hexagonal: Having six sides.

Hood: Anterior projection of the integument on some soft-bodied ticks.

Hypostome: Median ventral structure of the mouth parts that lies parallel to and between the palps and is immovably attached to the basis capituli. It bears recurved "teeth" or denticles. (*See* dentition.)

Inornate: Absence of a color pattern on the scutum.

Integument: Outer covering or cuticle of the tick's body.

Lateral: Toward the side.

Lateral groove: The groove running along the sides of the scutum in both sexes—may be continuous or interrupted.

Legs: Segmented appendages of which nymphs and adults have four pairs and larvae have three pairs.
From anterior to posterior the legs are identified by Roman numerals I, II, III, and IV. The segments from the proximal (next to the body) to the distal end are called coxa, trochanter, femur, tibia, metatarsus, and tarsus.

Macula: Large sclerotized structure located in the spiracular plate of adult ticks. It may be of variable size, shape, and location.

Mammillate: With nipplelike protuberances or processes.

Marginal groove: In females, the groove which runs along the sides of the body starting near the posterolateral border of the scutum.

Medial: Toward the median axis of the body.

Median: The longitudinal axis that divides the body.

Morphological: Pertaining to form or structure.

Ornamentation: Enamel-like color pattern that is superimposed on the base color of the integument in hard ticks. When present, this color pattern may be white to dirty white in *Dermacentor* or may be an intense copper or bronze color with touches of yellow or green in some *Amblyomma.*

Ornate: Definite color pattern superimposed on the base of the integument in hard ticks. (*See* ornamentation.)

Palps or palpi (sing. palpus): Paired articulated appendages located anterolaterally upon the basis capituli and lying parallel with the hypostome. Four distinct segments are present in soft ticks. In all hard ticks the fourth segment is reduced to a small hair-crowned papilla lying in a cuplike depression of segment 3. The sequence of numbering of the segments is indicated by Arabic numerals 1, 2, 3, and 4: 1 being the proximal segment (closest to the basis capituli).

Periphery: Circumference or outer margin.

Porose areas: A pair of pitted areas, usually depressed and oval, on the dorsal surface of the basis capituli; present in all adult female hard ticks; absent in male and immature stages.

Posterior: Toward the rear end.

Protuberance: Any elevation above the surface.

Proximal: Nearest to the point of attachment or origin.

Punctuations: Pits in the surface of the cuticle, frequently present on the scutum and sometimes present on the basis capituli of some of the hard ticks. The pits may be deep or shallow, small or large.

Scapulae (sing. scapula): Anterior angles or "shoulders" of the scutum that project on either side of the emargination.

Sclerotized: Hardened in definite areas by deposition or formation of organic or inorganic substances in the cuticula (termed sclerotin).

Segment: Distinct articulated entity of a palpus or a leg.

Scutum: The sclerotized dorsal plate posterior to the capitulum in hard ticks. It covers almost the entire dorsal surface in the male, about half the dorsal surface in the unengorged female. (*See engorged.*)

Spiracular plates: Paired plates located ventrolaterally and posterior to coxa IV in hard ticks; may be oval, rounded, or comma-shaped. In the soft ticks the spiracular plates are located ventrolaterally and opposite coxa IV and are usually round or oval. They are the external evidence of the respiratory system.

Spurs: Coxal spurs are projections from the posterior surface or posterior margin of the coxae; may be rounded or pointed, small or large. Projections on the median side are called internal spurs; those on the lateral side are called external spurs. Metatarsal spurs are small, pointed projections on the distal end of the metatarsus. Spurs may also be found on the palps of some species.

Subanal shields: Paired, projecting sclerotized structures on venter posterior to the adanal and accessory shields in males of *Hyalomma*.

Subapical dorsal protuberance: The subterminal protuberance present on the tarsus of some species of soft ticks. It should be distinguished from the dorsal humps which are present on the tarsus and metatarsus.

Subterminal: Before the end, or not quite attaining the end.

Sutural line: Distinct line around the outer margin separating dorsal and ventral surfaces in *Argas* ticks.

Tampan: A South African term referring to soft ticks, especially *Ornithodoros* and *Argas*.

Venter: Entire ventral or underside of the body.

Ventral: Pertaining to the underside of the body.

Ventral cornua: Very small projections arising from the posterolateral angles of the ventral surface of the basis capituli.

Ventral plaques: Small, non-projecting sclerotized plates on the venter immediately anterior to the festoons in the males of some species of *Amblyomma*.

Ventral scutes: Chitinous thickenings of the ventral surface of the festoons of *Amblyomma*. They may be distinct, protruding, faint, or absent.

XI. KEY TO FAMILIES OF TICKS

Scutum present, short in female, long in male. Capitulum at anterior of body in all stages..Family Ixodidae, p. 21

Scutum absent. Capitulum on underside of body in nymphs and adults, anterior in larvae...Family Argasidae, p. 29

Family Ixodidae

Morphological Characteristics of the Family

The family Ixodidae, the so-called "hard ticks," includes those ticks that have a scutum. Sexual dimorphism is pronounced, the dorsum of the male is almost completely covered by the scutum, and the body is incapable of becoming greatly enlarged; whereas, the dorsum of the female is only partially covered by the scutum and the body is capable of considerable enlargement. The scutum of the engorged female appears as only a small shield posterior to the capitulum. Porose areas are present on the basis capituli of the female, absent on the basis capituli of the male. The capitulum is always anterior and visible dorsally. The spiracular

plates are located posterior and somewhat lateral to coxa IV.

Key to Development Stages of Family Ixodidae

1. Six legs present.....Larvae
   Eight legs present.....2
2. Genital aperture not present (undeveloped). Scutum similar to the female type but basis capituli does not have porose areas.....Nymphs
   Genital aperture present. Scutum of male or female type. Basis capituli of female with porose areas.....Adults

Key to Genera of Adult of Family Ixodidae

1. Anal groove distinct and curves around the anus in front. Inornate. Eyes absent. Festoons absent.....Genus *Ixodes*, p. 27
   Anal groove located behind the anus or is absent. Ornate or inorate.
   Eyes present or absent. Festoons present or absent.....2
2. Second segment of palps projects beyond the lateral margin of the basis capituli. Eyes absent...Genus *Haemaphysalis*, p. 26
   Second segment of palps not projecting beyond the lateral margin of the basis capituli. Eyes usually present.....3
3. Basis capituli hexagonal (six-sided).[2] Usually inornate.....4
   Basis capituli not hexagonal dorsally. Ornate or inornate.....7
4. Festoons present. Spiracular plate comma-shaped or subtriangular. Coxae I deeply cleft.....5
   Festoons absent. Spiracular plate oval. Coxae I not deeply cleft in female.....6
5. Males with adanal shields and usually accessory shields. Coxae IV of male of normal size. Segment 1 of palps without dorsal spur....Genus *Rhipicephalus*, p. 28
   Males without adanal and accessory shields. Coxae IV of male greatly enlarged. Segment 1 of palps with dorsal spur.....Genus *Rhipicentor*, p. 28
6. Palps very short, compressed and ridged dorsally and laterally. Males with normal legs.....Genus *Boophilus*, p. 24
   Palps short, but not ridged dorsally and laterally. Males with massive, beady leg segments.....Genus *Margaropus*, p. 28
7. Palps short, second segment not twice as long as wide. Basis capituli rectangular dorsally.....Genus *Dermacentor*, p. 25
   Palps long, second segment twice as long as wide. Basis capituli of variable form, usually subtriangular or subrectangular dorsally.....8
8. Eyes absent. (Reptile parasites.....Genus *Aponomma*, p. 23
   Eyes present.....9
9. Scutum usually ornate.[3] Festoons well developed. Males without adanal shields, accessory shields and subanal shields.....Genus *Amblyomma*, p. 22
   Scutum inornate. Festoons poorly developed (often coalesced). Males with adanal shields, accessory shields, usually subanal shields.....Genus *Hyalomma*, p. 27

General Comments

The family Ixodidae is represented in North America by seven genera: *Amblyomma, Aponomma, Boophilus, Dermacentor, Haemaphysalis, Ixodes,* and *Rhipicephalus.* Additional genera found in other areas of the world include *Cosmiomma, Hyalomma, Margaropus,* and *Rhipicentor.* The principal hosts of the hard ticks are mammals, reptiles, amphibians, and birds. Generally, only those species known to be of economic importance as pests of livestock are stressed in this manual. (See charts, pp. 33–34.)

GENUS AMBLYOMMA

Morphological Characteristics of the Genus

Palps long, segment 2 at least twice as long as wide. Generally ornate. Eyes and festoons present. Basis capituli of variable form, usually subtriangular or subrectangular dorsally. Adanal shields absent in the male, but small ventral plaques may be present ventrally in

[2] An African species, *Rhipicephalus pulchellus*, not presently established in the United States, is one common exception; the male has a rectangular basis capituli and both sexes are ornate.

[3] *Amblyomma inornatum* lacks ornamentation.

front of the festoons. Ventral scutes may be present and extend beyond posterior margin of the festoons of the male. Spiracular plates subtriangular or comma-shaped.

Key to the Males of the United States

1. Scutum inornate....*Amblyomma inornatum*
   Scutum ornate 2
2. Coxa I with the internal spur moderately long.....3
   Coxa I with the internal spur short or insignificant.....4
3. Scutum with abundant ornate markings, more or less radiating from the center; markings most prevalent in central and anterior area of scutum.....*Amblyomma cajennense* or *A. imitator*[4]
   Scutum with sparse ornate markings, usually four or more symmetrically isolated patches; central area of scutum without ornate markings.....*Amblyomma americanum*
4. Coxae II, III, and IV each with one spur.....*Amblyomma maculatum*
   Coxae II, III, and IV each with two spurs..5
5. Coxa IV with the external spur distinctly longer than the internal spur.....*Amblyomma dissimile*
   Coxa IV with both spurs very short (internal spur may be difficult to see).....*Amblyomma tuberculatum*

Key to the Females of the United States

1. Scutum inornate....*Amblyomma inornatum*
   Scutum ornate 2
2. Coxa I with the external spur distinctly longer than the internal spur.....3
   Coxa I with external and internal spurs approximately but not exactly equal.....6
3. Scutum with scant ornamentation, usually limited to a distinct spot near the posterior end.....*Amblyomma americanum*
   Scutum with abundant ornamentation in an extensive pattern.....4
4. Coxa I with the internal spur very short or insignificant....*Amblyomma maculatum*
   Coxa I with the internal spur about half the length of the external spur.....5
5. Festoons with chitinous tubercles at posterointernal angle.....*Amblyomma cajennense*
   Festoons without chitinous tubercles .....*Amblyomma imitator*
6. Coxa IV with the external spur longer than the internal spur (often difficult to see or may be absent). Common on snakes and iguanas imported from South America.....*Amblyomma dissimile*
   Coxa IV with the internal and external spurs very small and about equal. Found on the gopher-tortoise in the coastal plain of Southeastern United States.....*Amblyomma tuberculatum*

General Comments

The genus *Amblyomma* is represented in the United States by at least seven species, four of which are commonly found on livestock. Those found on livestock include *A. americanum, A. cajennense, A. imitator,* and *A. maculatum.* Their distribution is limited usually to the southeastern or southwestern coastal States. The long mouth parts and the color pattern on the scutum are distinctive characters which aid in recognition of *Amblyomma* attacking livestock in the United States. Two species, *A. dissimile,* the iguana tick, and *A. tuberculatum,* the gopher-tortoise tick, as larvae and nymphs, have attached to and engorged upon bovines. Adults, however, usually attach only to reptiles and amphibians. The engorged adult *A. tuberculatum* may be almost an inch in length. Another species, *A. inornatum,* has been collected from dog, cow, coyote, deer, and rabbit in southern Texas.

Amblyomma americanum, the lone star tick, so named because of the conspicuous ornate spot on the posterior of the female scutum, is one of the more economically important species. The long mouth parts and great abundance of this tick make it an especially annoying pest of livestock. The wound produced predisposes livestock to attack by the screwworm fly, *Cochliomyia hominivorax.*

[4] Differentiation between the male *A. cajennense* and *A. imitator* is difficult. The male *A. imitator* is usually paler, narrower, and smaller. See Kohls' original description of *A. imitator* for additional information on the separation of the two species.

The lone star tick is also important from the public health standpoint because it is capable of transmitting tularemia, Rocky Mountain spotted fever, and Q fever; and it produces tick paralysis in man and dogs.

The lone star tick is more widely distributed in the United States than the other *Amblyomma* species. It is commonly found from Texas north to Missouri and eastward to the Atlantic coast. *A. americanum* is a 3–host tick. It may be active from early spring to late fall and all stages attack livestock and man.

Amblyomma cajennense, the Cayenne tick, has limited distribution in the United States, being confined to a few counties in southern Texas. In tropical Central and South America, this species has been reported abundant, active the year round and of definite economic importance as a livestock pest. It is a known vector of Rocky Mountain spotted fever in Mexico, Panama, Colombia, and Brazil. *A. cajennense* is a 3–host tick.

Amblyomma imitator was, until 1958, confused with *A. cajennense.* The species has been recorded from man and a variety of domestic and wild animals in southern Texas, Mexico, and Central America. Its definitive distribution, life history, and economic importance have not yet been determined.

Amblyomma maculatum, the Gulf Coast tick, is an important pest of livestock. The adults are usually found in clusters in the external ear where they produce an intense inflammation. Tick bites predispose the ear to attack by the screwworm fly. The Gulf Coast tick is found in those States bordering the Gulf of Mexico and along the Atlantic Coast of South Carolina, Georgia, and Florida. This species is rather exacting in its environmental requirements, usually preferring areas of high rainfall, temperature, and humidity. It is seldom found in great number more than 100 to 150 miles from the coast.[5] Livestock are attacked principally during the late summer and early fall. *A. maculatum* is a 3–host tick. The larva and nymph generally feed on birds and small mammals, while the adult prefers livestock.

[5] Established infestations of *A. maculatum* of livestock have been reported from at least 15 counties in Oklahoma.

In Africa members of the genus *Amblyomma* are frequently called bont ticks. The word "bont" is of Afrikaans origin and refers to the presence of brightly colored patterns on the scutum and the white-banded legs. This is an economically important group of ticks in Africa. Five species frequently found on livestock are *A. hebraeum, A. variegatum, A. gemma, A. pomposum,* and *A. lepidum.*

Amblyomma variegatum, the tropical bont tick, was found on cattle on St. Croix, U. S. Virgin Islands, in August 1967. Subsequently, *A. variegatum* was also collected from sheep, goats, dogs, horses, and mongooses. An eradication program started in late 1967 was completed by May 1970. In June 1974, *A. variegatum* was found established in Puerto Rico. See page 39.

The tropical bont tick was first reported in the Western Hemisphere (Antigua) in 1895. Apparently it had been introduced 30 to 40 years previously with cattle imported from Senegal, located on the west coast of Africa at about the same latitude as Antigua. It spread to St. Kitts and Guadeloupe, but it was not known to exist in the U. S. Virgin Islands before August 1967. The tropical bont tick is a serious pest of domestic livestock and has a broad host range. It is a known vector of the virus of Nairobi sheep disease and also transmits the agent which causes heartwater in cattle, sheep, and goats. Neither disease was found in the U. S. Virgin Islands.

Amblyomma hebraeum, the South African bont tick, has been reported on several occasions in the United States on rhinoceroses imported from South Africa. This is a 3–host tick that transmits the agent which causes heartwater in cattle, sheep, and goats.

GENUS APONOMMA

Morphological Characteristics of the Genus

Palps long, segment 2 at least twice as long as wide. Ornate or inornate. Eyes absent. Festoons present. Basis capituli rectangular or subrectangular dorsally.

The Species of Aponomma

No key to the species of *Aponomma* is included in this manual.

General Comments

The genus *Aponomma* closely resembles the genus *Amblyomma* except that *Aponomma* is smaller in size, broadly oval, and does not have eyes. This genus is found almost exclusively on reptiles and is of no known veterinary or medical importance. Only one species, *Aponomma elaphensis* Price, is known to be established in the United States; it is reported from the Trans-Pecos rat snake in the Big Bend National Park, Texas. Other species are occasionally found on snakes and lizards imported from Africa and South America.

GENUS BOOPHILUS

Morphological Characteristics of the Genus

Very short, compressed palps, ridged dorsally and laterally. Basis capituli hexagonal dorsally. Eyes present. Inornate. Festoons absent. Spiracular plate rounded or oval. Male with adanal shields and accessory shields. Anal groove indistinct or absent in female, faint in male. Caudal process present or absent in male.

Key to the Males of North America

With caudal process at posterior extremity of body.....*B. microplus*
Without caudal process.....*B. annulatus*

Key to the Females of North America [6]

With internal and external spurs of coxa I broadly rounded and wider than long. Coxae II and III with external spurs broadly rounded and wider than long. Coxa IV with or without a very small external spur..*Boophilus microplus*

Internal spur of coxa I absent, external spur broadly rounded and wider than long. Coxae II, III and IV without external spurs .....*B. annulatus*

General Comments

Ticks of the genus *Boophilus* have been eradicated from the United States—except for a small, narrow quarantine zone along the Texas-Mexico border. Periodic reinfestations in the quarantine zone occur from adjacent heavily infested areas of Mexico.

The cattle fever tick, *B. annulatus,* was formerly the most common and most economically important tick attacking livestock, particularly cattle, in the Southern States. As a vector of *Babesia bigemina,* the causative agent of bovine piroplasmosis (cattle fever), this tick and the disease it transmits cost the livestock industry an estimated $100 million annually prior to the start of the Tick Eradication Program in 1906.

Boophilus microplus, the tropical cattle tick, was also once established in the United States. It is closely related to *B. annulatus,* and the females are sometimes difficult to differentiate. Both species are 1–host ticks that prefer similar hosts, and both species are vectors of piroplasmosis and anaplasmosis. As the name implies, the tropical cattle tick prefers a tropical or subtropical climate. In the United States, in the past, it was reported most frequently from Florida and extreme southern Texas. The tropical cattle tick is very prevalent in the more humid and hotter parts of the West Indies, Central America, Mexico, South America, Australia, Africa, and the Orient.

Boophilus decoloratus, an African species closely related to *B. microplus,* has been found on wild animals from Africa held in quarantine before being released for entry into the United States. In South Africa this is one of the commonest species parasitizing cattle and less frequently horses. The biology and disease relationships are similar to those of *B. microplus.*

GENUS DERMACENTOR

Morphological Characteristics of the Genus

Basis capituli rectangular dorsally. Eyes and festoons present. Palps short, broad, or moderate. Coxae I to IV of males increase progressively in size; in all species coxa IV is the largest. Male without ventral plates or shields. Coxa I bifid in both sexes. Spiracular plates sub-oval or comma-shaped. Usually ornate.

[6] Females of some populations are very difficult to separate due to morphological variation. Accurate identification is best accomplished with male specimens.

Key to the Adults of the United States

1. Spurs on coxa I widely divergent.....2
   Spurs on coxa I not divergent or only slightly divergent 4
2. Scutum inornate. Spiracular plate without dorsal prolongation and with few (usually 4–10), large, isolated goblets. Seven festoons present (not distinct on engorged female).....*Dermacentor nitens (=Anocentor nitens)*
   Scutum ornate. Spiracular plate with dorsal prolongation and with many small or medium sized goblets. Eleven festoons present 3
3. Scutum with large, deep punctations. Cervical grooves of female deep and extend nearly half the length of scutum. (Primarily a rabbit tick of the Southwestern United States and adjacent area of Mexico) ....*Dermacentor parumapertus*
   Scutum with the punctations shallow and moderate in size. Cervical grooves of female deep and short, scarcely more than pits. Found on peccary (javelina) in Texas and Mexico.....*Dermacentor halli*
4. Spiracular plate *without dorsal prolongation*[7] and with goblets of medium size and number.....5
   Spiracular plate *with dorsal prolongation* and with goblets many or of moderate numbers 6
5. Scutum and legs profusely covered with white ornamentation.....*Dermacentor albipictus*
   Scutum without white or with very little white ornamentation. Common on deer in Southeastern United States of America.....*Dermacentor nigrolineatus*
6. Cornua long, especially in the male (found along Pacific Coast of California and Oregon).....*Dermacentor occidentalis*
   Cornua short or of moderate length.....7
7. Spiracular plate with goblets very small and numerous (like grains of sand) .....*Dermacentor variabilis*
   Spiracular plate with goblets moderate in size and number.....8
8. The larger punctations on scutum very large and deep.....*Dermacentor andersoni (=D. venustus)*
   The larger punctations on scutum moderate in size and depth. From bighorn sheep in Arizona and Mexico..... *Dermacentor hunteri*

[7] The frame of the spiracular plate of some specimens of *D. albipictus* is occasionally formed to resemble a partially developed dorsal prolongation. When such a specimen is encountered, one may possibly identify it as *D. hunteri* with this key. However, the dorsal prolongation is very definite in *D. hunteri.*

General Comments

The genus *Dermacentor* comprises an important group of ticks in the United States, particularly as vectors of disease-producing organisms affecting man. Several of the species are known transmitters of Rocky Mountain spotted fever, tularemia, Colorado tick fever, and Q fever; some species may produce tick paralysis. Several members of this genus are also important pests of livestock, both as disease vectors and as bloodsucking parasites.

This genus is represented in the United States by at least nine species, six of which commonly attack livestock. *D. andersoni (= D. venustus), D. occidentalis,* and *D. variabilis* are 3–host ticks. *Dermacentor albipictus* and the closely related *D. nigrolineatus,* as well as *D. nitens,* are 1–host ticks. The three additional species *D. halli, D. hunteri,* and *D. parumapertus* do not commonly attack livestock.

Dermacentor nitens (= Anocentor nitens), the tropical horse tick, is an important parasite of horses, mules, and asses in parts of Mexico, Central America, and the West Indies. Until about 1960, it was believed the tropical horse tick was established in the United States only in extreme southern Texas. Evidence now indicates that this species is also well established in southern Florida. *Dermacentor nitens* is a 1–host tick. It is usually found in the ears of horses, mules, and asses, although it has also been found on cattle, goats, and deer. In heavy infestations on horses, it has also been found in the nasal diverticulae, the mane, the perineal region, and along the ventral midline.

Dermacentor albipictus, the winter tick, is an important pest of horses, cattle, moose, elk, and deer in the northern and western United States. It is often abundant on range stock and, if not controlled, may cause losses through weakened condition or death of the host. This 1–host tick is active during the late fall, winter, and early spring.

Dermacentor nigrolineatus, the brown winter tick, is closely related to *D. albipictus*. In fact, some taxonomists regard *D. nigrolineatus* as a variation or "form" of *D. albipictus*. Other authorities regard the completely inornate *D. nigrolineatus* as a valid species.

The brown winter tick is widely scattered throughout the eastern half of the United States, both north and south, although the incidence of this species is greater in the southeastern quarter of the country. In southwestern Texas and New Mexico, the distribution of *D. albipictus* and *D. nigrolineatus* may have overlapped with a crossing of the two species resulting in a fertile hybrid which is sometimes difficult to place in either species. The preferred host for the brown winter tick in the southeastern states is the white-tailed deer, although it will also attack horses, mules, and cattle. It is a 1–host tick and is found on animals only during fall, winter, and spring.

Dermacentor occidentalis, the Pacific Coast tick, is common from Oregon to lower California. This species occurs on a variety of domestic animals with occasional heavy infestations on deer. Adult ticks are most numerous on hosts during the rainy season. All stages of the tick have been reported on cattle. This is a 3–host tick.

Dermacentor variabilis, the American dog tick, is widely distributed in the United States. It is found in all the States east of the Rocky Mountains, as well as in California, Washington, Idaho, and Oregon. The American dog tick is an important vector of Rocky Mountain spotted fever in the Eastern States. It transmits tularemia and possibly bovine anaplasmosis and produces tick paralysis. *D. variabilis* is a 3–host tick. Although the dog is the preferred host for the adult tick, man, as well as domestic and wild animals, is frequently attacked. The larva and nymph prefer small rodents, especially mice, rats, and rabbits.

Dermacentor andersoni (= D. venustus), the Rocky Mountain wood tick, is one of the most infamous transmitters of diseases of man in the United States. It is a vector of Rocky Mountain spotted fever, tularemia, Colorado tick fever, and Q fever; and produces tick paralysis in both man and animals. It is also a suspected vector of anaplasmosis in cattle. This species has been reported in 14 Northwestern States and in three provinces of southwestern Canada. It is a 3–host tick. The nymph and larva feed primarily on small animals, such as squirrels, chipmunks, and rabbits; whereas, the adults generally attack the larger mammals—horses, cattle, sheep, deer, and man.

GENUS HAEMAPHYSALIS

Morphological Characteristics of the Genus

Inornate. Eyes absent. Festoons present. Usually short conical palps with second segment projecting beyond the lateral margin of the basis capituli which is rectangular in the dorsal view. Usually of small size and sexual dimorphism slight. Ventral plates or shields absent in the male. Posterior margin of coxa I never bifid or deeply cleft. Spiracular plates usually rounded or comma-shaped in the male, rounded or oval in the female.

Key to the Adults of the United States

Ventral cornua present. Dentition of hypostome 3/3 . . *Haemaphysalis leporispalustris*
Ventral cornua absent. Dentition of hypostome 5/5 . . . . . *H. chordeilis*

General Comments

The genus *Haemaphysalis* includes approximately 150 species. Only two species, *H. leporispalustris* and *H. chordeilis*, are known to be established in the United States. Neither is commonly found on livestock. Both species are 3–host ticks.

Haemaphysalis leporispalustris, the rabbit tick, is widely distributed in the United States from Massachusetts to California. The adult is found primarily on rabbits and ground-frequenting birds; whereas, the larva and nymph are usually found on numerous kinds of birds and small mammals. None of the stages are commonly found on livestock or man. This species may be more important than is realized.

Evidence indicates that the rabbit tick may be an important factor in the spread of Rocky Mountain spotted fever and tularemia among wild animal reservoir hosts.

Haemaphysalis chordeilis, the bird tick, is also widely distributed in the United States. Birds are the preferred hosts for all stages of the species, and livestock and man are only rarely attacked. Several authorities have reported deaths in turkeys and wild game birds from heavy infestations of this species.

Some important species of *Haemaphysalis* in other areas of the world are *H. leachi* of Africa, *H. longicornis* of Australia, New Zealand and Japan; and *H. bispinosa* of Ceylon, Pakistan, India, and Malaysia.

GENUS HYALOMMA

Morphological Characteristics of the Genus

Ornamentation, if present, limited to pale bands on legs. Eyes present. Festoons irregular, partially coalesced. Palps long, segment 2 approximately twice as long as segment 3. Basis capituli subtriangular dorsally. Coxa I usually deeply cleft. The male with adanal and accessory shields and usually subanal shields. Spiracular plate usually comma-shaped.

The Species of Hyalomma

No key to the species of *Hyalomma* is included. All suspected specimens of *Hyalomma* ticks should, without exception, be forwarded to the Veterinary Services Laboratories for identification or confirmation.

General Comments

Until relatively recently the taxonomic status of the species in the genus *Hyalomma* was confused. However, thanks to Hoogstraal and Kaiser, this group is now reasonably well understood. The *Hyalomma* complex of species, which at one time consisted of almost 100 species or subspecies, is now recognized as consisting of approximately two dozen or fewer valid species.

Fortunately, the genus *Hyalomma* is not represented in the New World. It is distributed throughout Asia, Africa, and southern Europe.

Adult *Hyalomma* ticks are primarily parasites of domestic animals and are of considerable economic importance in areas where they are established. The species of this genus are especially efficient vectors of a variety of disease-producing organisms of man and animals. *Hyalomma* ticks are probably among the most economically important external parasites which attack animals.

GENUS IXODES

Morphological Characteristics of the Genus

Anal groove distinct and curves around the anus anteriorly, and usually uniting in a point or arch. Inornate. Eyes and festoons absent. Palps and basis capituli of variable form. Spiracular plates round or oval. Venter of male covered with seven nonprojecting, armor-like plates. Sexual dimorphism pronounced, especially in regard to the capitulum.

The Species of Ixodes

Due to the complexity of the ticks in this genus, no attempt has been made to present a key for the identification of the species. It is suggested that all *Ixodes* be referred to a specialist for identification. For information on the identification and distribution of the species in the United States, refer to Cooley and Kohls (1945).

General Comments

Some 200 species of the genus *Ixodes* are found throughout the world. Over 30 species have been reported in the United States. Only two species, however, *I. pacificus* and *I. scapularis,* are commonly found on livestock in the United States; both are 3-host ticks. The long mouth parts of the female *Ixodes* enable these ticks to be especially painful and annoying parasites of livestock and man.

Ixodes pacificus, the California black-legged tick, is commonly found on domestic livestock, deer, and man along the western coast of the United States from Mexico to British Columbia. Records indicate that this species is most abundant on livestock during the spring.

Ixodes scapularis, the black-legged tick, is found primarily from Texas and Oklahoma eastward to the Atlantic Ocean, but it has been reported as far north as Minnesota and Wisconsin and as far northeast as southern Massachusetts. In the Southern States, where this

species is commonly found, it is abundant in winter and early spring. This tick is not known to naturally transmit livestock diseases; it is a suspected vector of anaplasmosis and tularemia. Also, see footnote on p. 51.

Other important species of *Ixodes* are *I. ricinus* of Europe, *I. persulcatus* of parts of Asia and parts of Europe, *I. holocyclus* of Australia, and *I. rubicundus* of southern Africa.

GENUS MARGAROPUS

Morphological Characteristics of the Genus

Palps short but not ridged as in *Boophilus*. Basis capituli hexagonal dorsally. Eyes present. Inornate. Festoons absent. Legs of male increase progressively in size from pair I to IV; the segements of leg IV greatly enlarged. Male with adanal and sometimes accessory shields. Spiracular plates rounded or oval in both sexes. Anal groove absent or indistinct.

The Species of Margaropus

No key to the species is included in this manual. See Hoogstraal (1956).

General Comments

The genus *Margaropus* is closely related to *Boophilus* and is known to be established only in Africa. At one time *Boophilus annulatus* was placed in the genus *Margaropus*, and much of the older literature lists *B. annulatus* as *Margaropus annulatus*.

Only two species, *M. winthemi* and *M. reidi* are presently included in this genus. *Margaropus winthemi* is found in southern Africa and feeds chiefly on horses and cattle; it is a 1-host tick and the female resembles *B. decoloratus*, but is larger. *Margaropus reidi* is reported only from the giraffe in the western Sudan; the biology and disease relations are unstudied.

GENUS RHIPICENTOR

Morphological Characteristics of the Genus

Inornate. Eyes present. Festoons present. Basis capituli hexagonal dorsally. Palps short; segment 1 with a short broad dorsal spur. Coxa I unusually long and deeply cleft. Spiracular plates subtriangular or comma-shaped. The male resembles *Rhipicephalus* dorsally, *Dermacentor* ventrally; coxa IV is greatly enlarged; adanal shields and accessory shields absent. All coxae with a well developed antero-external prolongation which is spurlike in coxa I. Coxal spurs are sharper than in *Rhipicephalus*.

The Species of Rhipicentor

No key to the species is included in this manual. *See Theiler (1961).*

General Comments

The genus *Rhipicentor* presently contains two species and both are established only in Africa. *Rhipicentor bicornis* has been reported from goats, horses, cattle, dogs, and wild carnivores in southern and central Africa. The biology and disease relationships are unstudied, but since it does parasitize domestic animals it is potentially dangerous. *Rhipicentor nuttalli* has been reported from hedgehogs, dogs, hyenas, wild cats, large carnivores, and cattle in southern Africa.

GENUS RHIPICEPHALUS

Morphological Characteristics of the Genus

Palps short and basis capituli usually hexagonal dorsally. Usually inornate. Eyes and festoons present. Coxa I deeply cleft. Males with adanal shields and usually accessory shields. Spiracular plates comma-shaped. Caudal process present or absent in male.

The Species of Rhipicephalus

Due to the number, complexity, and economic importance of the species in the genus *Rhipicephalus*, no key is included in this manual. All *Rhipicephalus* ticks should be submitted to the Veterinary Service Laboratories, Beltsville, Md., for identification or confirmation.

General Comments

The genus *Rhipicephalus* apparently originated in Africa where some 60 species are now found. These ticks are especially important as reservoirs and vectors of a variety of animal diseases. Some of the economically important diseases transmitted or produced by

Rhipicephalus ticks include piroplasmosis, anaplasmosis, theileriosis, tick toxicosis, and spirochetosis.

At least three species of *Rhipicephalus*, namely *R. evertsi*, *R. pulchellus*, and *R. appendiculatus*, are occasionally found on zoo-type animals being held in quarantine at the USDA Animal Import Center at Clifton, N.J. Other important species in Africa are *R. capensis*, *R. pravus*, and *R. simus*.

At the present time, *R. sanguineus* is the only species of this genus established in the United States. However, in 1960 *R. evertsi*, the red-legged tick, was found on a variety of zoo animals in two wild animal compounds in Florida and a game farm in New York. Based on the degree of infestation and number of animals infested, the red-legged tick had been established in one of the zoological compounds in Florida for approximately 2 or 3 years. Following an intensive eradication program, the red-legged tick was eliminated from the United States by 1961.

Family Argasidae

Morphological Characteristics of the Family

The family Argasidae, "soft ticks," consists of those ticks that lack a scutum. Sexual dimorphism is not marked; the males closely resemble the females. Porose areas are absent. The capitulum of the nymphs and adults is always ventral and not visible dorsally, except for the distal end of the palps, which sometimes project beyond the anterior margin of the body. The capitulum is anterior in the larvae. The spiracular plates usually are located anterior to coxa IV.

Key to Development Stages of Family Argasidae

1. Six legs present.....Larvae
   Eight legs present.....2
2. Genital aperture undeveloped; in large nymphs may appear as a small depression .....Nymphs
   Genital aperture well developed.....Adults

Key to Genera of Family Argasidae

1. Margin of body thin and acute with a definite sutural line separating the dorsal and ventral surfaces.....Genus *Argas*, p. 30
   Margin of body thick, rounded, and without a definite sutural line separating the dorsal and ventral surfaces.....2
2. Integument of nymph covered with spines. Adult with granular integument and poorly developed hypostome.....Genus *Otobius*, p. 31
   Integument of nymph and adult mammillated and without spines. Adult with well-developed hypostome.....Genus *Ornithodoros*, p. 30

General Comments

The family Argasidae is represented in the United States by four genera, three of which have been found on livestock and poultry—*Argas*, *Otobius*, and *Ornithodoros*. The fourth genus, *Antricola*, has been found in bat guano and is suspected of feeding on bats.

The *Argas persicus* complex of species, although not presently of much economic importance, was once a serious pest of domestic fowl in Florida and several Southwestern States. The spinose ear tick, *Otobius megnini*, is the only soft tick commonly found on livestock in the United States. Ticks of the genus *Ornithodoros* are not usually important parasites of livestock, although several species are important vectors of the spirochetes of relapsing fever in man. The principal host of the soft ticks include birds, rodents, and bats—occasionally livestock and man. *(See* chart on p. 35).

The South Africans commonly refer to most soft ticks as tampans, but this term has not gained acceptance in the United States.

GENUS ARGAS

Morphological Characteristics of the Genus

Body distinctly flattened with dorsal and ventral surfaces approximately equal in area. Margin of body flattened and composed of radial striae or quadrangular plates. Sutural line

present. Integument leathery, minutely wrinkled in folds, often intermingled with small, rounded "buttons," each with a pit on top and often bearing a hair in the pit. Eyes absent. Sexes similar. Nymphs and adults similar.

The Species of Argas

Due to the complexity of this genus, no key is included to separate the species of *Argas*. See Kohls *et al* (1970).

General Comments

It has been found that the ticks commonly identified as *Argas persicus* in the United States actually represent a complex of species. The true *A. persicus*, an Old World species, is apparently rather rare in the New World. The common *Argas* species found in the United States are *A. radiatus* and *A. sanchezi*; a fourth species, *A. miniatus*, may also occur, but definite proof of its presence is still lacking. These four closely related species have been reported from domestic poultry in the New World. *Argas radiatus* and *A. sanchezi* have also been found on various wild birds. Three additional species, *A. brevipes*, *A. cooleyi*, and *A. giganteus*, have been reported from or associated with wild birds in the western United States. The genus *Argas* is of little economic importance as pests of livestock in the United States.

GENUS ORNITHODOROS

Morphological Characteristics of the Genus

Capitulum either subterminal or distant from anterior margin. Hypostome well developed and essentially alike in both adult sexes and in nymphs. Integument with discs and mammillae commingling in a variety of patterns. Hood, camerostome, and checks present or absent. Eyes present or absent. Dorsal humps and subapical dorsal protuberances on legs progressively more prominent in successive nymphal stages. Body more or less flattened but strongly convex dorsally when distended. Integumental pattern continuous over sides from dorsal to ventral surfaces.

Key to the Adults Most Commonly Found on Livestock in the United States

1. Cheeks present.....*Ornithodoros talaje*
   Cheeks absent.....2
2. Eyes present (on sides of body above second and third coxae). Tarsus IV with prominent subapical dorsal protuberance. (Reported from Pacific Coast of California and Mexico) ..... *Ornithodoros coriaceus*
   Eyes absent. Tarsus of leg IV without subapical dorsal protuberance .....*Ornithodoros turicata*

General Comments

This genus is well represented in the United States, especially in the Southwestern and Western States, with some 15 species being reported. Several species occasionally attack livestock, but generally *Ornithodoros* ticks are not a problem as pests of domesticated animals. This genus is primarily significant as the vector of spirochetes of relapsing fever in man.

Ornithodoros turicata, the relapsing fever tick, and *O. talaje*, which has no common name, occasionally attack domestic animals in the United States. These species have been reported from the Southwestern States and Florida. They are not known to be vectors of livestock diseases, but are vectors of relapsing fever in man in the Southwestern States.

O. coriaceus, the pajaroello tick, has been taken from cattle and deer in California and the Pacific Coast region of Mexico. It readily attacks man and its venomous "bite" is said to be very painful. This tick, however, is not known to be a disease vector.

In other areas of the world, particularly Africa and Asia, *Ornithodoros* ticks are important as reservoirs and vectors of disease-producing organisms of man and animals. Some of these species are *O. erraticus* of northern Africa, Portugal, and Spain, *O. tholozani* of central Asia, *O. savignyi* of Africa and Asia, and the *O. moubata* species complex of Africa.

GENUS OTOBIUS

Morphological Characteristics of the Genus

Integument of nymph covered with spines. Integument of adult granulated. Sexes similar. Capitulum distant from the anterior margin in adults, near the margin in nymphs. Hood and eyes absent. Hypostome well developed in nymphs, vestigial in adults.

Key to the Nymphs

Integument with numerous heavy spines anteriorly and lighter spines posteriorly. Dentition of hypostome 4/4. Spiracles conical ..... *O. megnini*

Integument with numerous spines all of one size. Dentition of hypostome 3/3. Spiracles convex..... *O. lagophilus*

Key to the Adults [8]

Pits on dorsal surface of body separated by a distance of two or more times the diameter of one pit..... *Otobius megnini*

Pits on the dorsal surface of body separated by a distance of the diameter or less of one pit..... *O. lagophilus*

[8] The adults are not parasitic and are not likely to be found on animals.

General Comments

The genus *Otobius* presently contains only two species, *O. megnini* and *O. lagophilus,* both of which are found in the United States. The spinose ear tick, *O. megnini,* is a common and important pest in the Southwestern States. It is primarily reported from livestock, particularly cattle and horses, although other domestic and wild animals are attacked. The larval and nymphal stages are found in the ears. The nymph is easily recognizable by the spines on the integument and the violin-like shape of the body. The adult stage of *O. megnini* differs from the nymphal stages in that the integument lacks spines; the hypostome is poorly developed, and it does not feed.

The spinose ear tick is the only species of *Otobius* reported from livestock. *Otobius lagophilus* is found on rabbits in the western United States, Mexico, and Alberta, Canada. Like *O. megnini,* the adults of *O. lagophilus* are not parasitic.

XII. COLLECTING AND PRESERVING TICKS

Finding ticks on an animal often requires careful examination of all parts of the animal. Some species of ticks, such as the spinose ear tick, tropical horse tick, and the larval and nymphal stages of the red-legged tick, are almost always attached in the ear of the host. Other species prefer the thin skin between the hind legs, under the base of the tail, or on the brisket. Some ticks have been collected from the eyelids and the tongues of animals. In inspecting an animal for ticks, use the fingers as well as the eyes, for often a tick that cannot be seen may be felt. If possible, watch a trained tick inspector at work and note how carefully he moves his fingers over an animal.

Female ticks, ordinarily much larger than the males, are easy to find. Careful scrutiny of the area near the female tick frequently will also reveal a tiny male tick.

Remove ticks from the host carefully so as not to break off the capitulum (false head)—especially in removing ticks with long mouth-

parts such as *Ixodes* and *Amblyomma* species. Forceps are useful to grasp the tick near the head end and "tease" it off. Ticks with short mouthparts, as in the cattle fever tick, are readily removed without injury.

Ticks often may be collected from grass and other vegetation, where they are awaiting a host, by dragging a flannel cloth over the area. This procedure is referred to as "dragging" or "flagging" for ticks. The drag is made by attaching one end of the flannel cloth (about 30″ × 60″) to a piece of wood, such as a broomstick, to which a strong cord is attached for a towline.

For use in brush or scrub, Stampa's modification of the drag or flag is recommended. The drag is cut into tails, slightly weighted, so that they will fall between the higher twigs and come into contact with the inner parts of the brush where the ticks are often found.

Blood tubes or screwcap vials are satisfactory containers for tick specimens. Cattle fever ticks and other disease vectors should be put in vials containing a preserving fluid before removal from an infested property. Tick specimens can be preserved in 70 percent isopropyl alcohol (rubbing alcohol).

Ticks from different species of hosts should never be mixed. For example, ticks collected from cattle should not be mixed with ticks collected from horses, even when collected on the same farm or ranch.

Any additional information is valuable in determining the distribution of a species of tick. For example, "Four ticks were collected from inside ear and two ticks from between hind legs of a young Hereford cow. Animal pastured in dense woodland and only 1 in herd of 20 found to be infested. This animal was purchased about 1 month ago from Paul Cannon at Coleman, Texas."

Where to Submit Ticks for Identification or Confirmation—All suspected cattle fever ticks and other exotic species should be forwarded for confirmation and cataloging through the area Veterinarian in Charge to:

Veterinary Services Laboratories
APHIS, USDA

Parasitology Laboratory
Bldg. 322, BARC–East
Beltsville, Maryland 20705

Each tick or group of ticks collected from an animal should be properly labeled, and if possible, should always include at least the following information:

(1) Type animal from which specimen(s) taken	Cow, Hereford
(2) Geographical location where ticks are collected (city, county, and State).	Hamlin, Jones County, Texas
(3) Owner's name and address [9]	D. W. Scott
(4) Number of specimens	7 ticks
(5) Collector's name	B. F. Hall
(6) Date collected	October 21, 1974

[9] This may not always be the same as (2).

XIII. HOSTS, DISTRIBUTION AND DISEASES TRANSMITTED BY SELECTED TICKS

Hard Ticks (Ixodidae)

Scientific name	Common name	Current distribution	Common hosts [1]	Diseases produced or transmitted
Amblyomma americanum (Linnaeus)	Lone Star tick	Texas, north to Iowa and eastward to Atlantic coast. Mexico, Central and South America.	Livestock, dog, deer, and man. Birds (larvae and nymphs).	Rocky Mountain spotted fever, Q fever, tularemia, and tick paralysis.
Amblyomma cajennense (Fabricius)	Cayenne tick	Southern Texas, Mexico, Central and South America.	Livestock, dog, deer, and man.	Spotted fever, Q fever, and brucellosis (experimental).
Amblyomma imitator Kohls	None	Southern Texas, Mexico, and Central America.	Livestock, dog, deer, peccary, and man.	Unstudied.
Amblyomma inornatum (Banks)	None	Southern Texas, probably Mexico.	Cow, dog, bobcat, rabbits, and deer.	Unstudied.
Amblyomma maculatum Koch	Gulf Coast tick	U.S. Gulf Coast States, Arkansas, Georgia, Oklahoma, and South Carolina. Central and South America.	Livestock, dog, deer, and man. Birds (larvae and nymphs).	Tick paralysis.
Boophilus annulatus (Say)	Cattle fever tick	Mexico, West and Central Africa, the Sudan, Mediterranean Basin, and the Near East.	Livestock (primarily cattle) and occasionally deer.	Bovine piroplasmosis, bovine anaplasmosis, and brucellosis (experimental).
Boophilus microplus (Canestrini)	Tropical cattle tick	Mexico, Central and South America, West Indies, Australia, Africa, and the Orient.	Livestock (primarily cattle) and occasionally deer.	Bovine piroplasmosis and bovine anaplasmosis.
Dermacentor albipictus (Packard)	Winter tick	Primarily Northern and Western U.S.A., and Canada.	Livestock, deer, elk, and moose.	Bovine anaplasmosis?
Dermacentor andersoni Stiles (=D. *venustus Banks*)	Rocky Mountain wood tick	Northwestern U.S.A. and adjacent Western States. British Columbia and Manitoba, Canada.	Livestock, dog, deer, and other large wildlife and man. Small mammals (larvae and nymphs).	Rocky Mountain spotted fever, Colorado tick fever, tularemia, Q fever, bovine anaplasmosis?, and tick paralysis.
Dermacentor nigrolineatus Packard	Brown winter tick	Texas, Oklahoma, Kansas, and large area of eastern half of U.S.A., and Mexico.	Livestock and deer.	Bovine anaplasmosis?

See footnotes at end of table.

XIII. HOSTS, DISTRIBUTION, AND DISEASES TRANSMITTED BY SELECTED TICKS—Continued

Hard ticks (Ixodidae)—Continued

Scientific name	Common name	Current distribution	Common hosts [1]	Diseases produced or transmitted
Dermacentor nitens Neumann (=*Anocentor nitens*)	Tropical horse tick	Southern Texas, Florida, West Indies, Mexico, Central and South America.	Primarily horses, also cattle and deer.	Equine piroplasmosis.
Dermacentor occidentalis Marx	Pacific Coast tick	California, Oregon, and Pacific coast of Mexico.	Livestock, deer, dog, and man.	Tick paralysis, bovine anaplasmosis, Q fever, Rocky Mountain Spotted Fever, Colorado tick fever, tularemia.
Dermacentor parumapertus Neumann	Rabbit Dermacentor	Southwestern U.S.A.	Primarily rabbits, occasionally cattle, and deer. Small mammals (larvae and nymphs).	Transmits Rocky Mountain Spotted Fever among rabbits in nature. Suspected vector of tularemia among rabbits.
Dermacentor variabilis (Say)	American dog tick	Eastern two-thirds of U.S.A., California, Idaho, Oregon, Washington, Canada, and Mexico.	Livestock, dog, deer, and man. Small mammals (larvae and nymphs).	Rocky Mountain Spotted Fever, tularemia, bovine anaplasmosis?, tick paralysis.
Haemaphysalis chordeilis (Packard)	Bird tick	Widely distributed in U.S.A. and Canada.	Various ground-inhabiting birds.	
Haemaphysalis leporispalustris (Packard)	Rabbit tick	Widely distributed in New World from Alaska to Argentina.	Rabbits. Various ground-inhabiting birds (larvae and nymphs).	Tularemia, Rocky Mountain Spotted fever, and Q fever.
Ixodes pacificus Cooley and Kohls	California black-legged tick	Washington, Oregon California, and British Columbia, Canada.	Livestock, dogs, deer and man. Mice and lizards (larvae and nymphs).	Suspected vector of tularemia.
Ixodes scapularis Say	Black-legged tick	Primarily Southeastern and Southern U.S.A.	Livestock, deer and dogs. Birds and lizards (larvae and nymphs).	Experimentally bovine anaplasmosis and tularemia.
Rhipicephalus sanguineus (Latreille)	Brown dog tick or Kennel tick	Widely distributed throughout U.S.A. and the world.	Dog, rarely livestock, and man in U.S.A.	Canine piroplasmosis, tick paralysis, canine ehrlichiosis, Q fever, Rocky Moutain spotted fever, and boutonneuse fever. Tularemia (experimental).

Soft Ticks (Argasidae)

Scientific name	Common name	Current distribution	Common hosts [1]	Diseases produced or transmitted
Argas persicus [2] (Oken)	Fowl tick (blue bug)	Widely distributed throughout tropical and warm-temperate areas of the World.	Domestic and wild fowl, rarely man and livestock in U.S.A.	Fowl spirochetosis, fowl piroplasmosis (Asia and Africa). Bovine anaplasmosis (experimental).
Ornithodoros coriaceus Koch	Pajaroello tick	California, Pacific coast of Mexico.	Cattle, deer, man.	Has painful venomous "bite."
Ornithodoros talaje (Guérin-Méneville)	None	Florida, Kansas, and Southwestern U.S.A. Mexico Central and South America.	Rodents, dog, cat, and man.	Relapsing fever.
Ornithodoros turicata (Dugès)	Relapsing-fever tick	Florida, Southewestern U.S.A. and Mexico.	Rodents, livestock, reptiles, and man.	Relapsing fever.
Otobius megnini (Dugès)	Spinose ear tick	Primarily Southwestern and western U.S.A. Mexico, Central and South America, Africa, and India.	Livestock, dog, and large wildlife. Rarely man.	Suspected vector of Q fever.

[1] Common hosts are not necessarily listed in order of importance or preference. All stages of the tick are not necessarily found on the hosts listed.

[2] See p. 30 for discussion.

XIV. LIFE HISTORY SUMMARIES OF SELECTED TICKS OF VETERINARY IMPORTANCE

The data presented in each of the following life history summaries was collected from a number of sources. The intent is to present a picture of possible tick development for selected species of ticks. A tick may not necessarily complete all stages of the life cycle within the period of time given in the life history summary. The life history summaries indicate the wide range of variation which may be possible with a given species of tick. This information was obtained in the laboratory or under simulated field conditions and does not necessarily indicate the rate of development under natural field conditions.

Assuming that the relative humidity and precipitation are adequate for survival, temperature is the most important factor affecting the length of the life cycle. Generally, the parasitic period for each species is relatively constant in length, but the nonparasitic period is often highly variable. The lower the temperature is, the longer it takes a tick to go through the nonparasitic period. For instance, the life cycle of *Haemaphysalis leporispalustris* can be expected to take longer in northern Pennsylvania than in southern Texas.

Amblyomma americanum (Linnaeus), the Lone Star tick

DISTRIBUTION

This tick is distributed from central and eastern Texas, north into Missouri, and east in a broad belt to the Atlantic coast. It has also been reported in Mexico, Guatemala, Guyana, and French Guiana.

HOSTS

This species has a wide host range. The adults are commonly found on large mammals such as cattle, horses, deer, and dogs. Although the larvae and nymphs attach to the same hosts as the adults, they prefer to feed on birds and small mammals. All three parasitic stages attack man.

LOCATION ON HOST

On livestock, all stages of this tick prefer attachment to thin-skinned areas such as the ears, dewlap, escutcheon, axillary region, and inguinal region; however, in heavy infestations they may be found attached all over the body.

SEASONAL ACTIVITY

The Lone Star tick is most commonly found on livestock in the spring and summer. In the lower Southern States all parasitic stages have been taken on hosts throughout the year.

LIFE CYCLE SUMMARY

The following life history information is adapted from Hooker, Bishopp, and Wood:

Amblyomma americanum is a 3-host tick.

The female lays	up to 8,300 eggs
Preoviposition period	5–13 days
Oviposition period	7–23 days
Incubation of eggs	23–117 days
Larvae engorge	3–9 days
Larvae molt	8–26 days
Nymphs engorge	3–8 days
Nymphs molt	13–46 days
Females engorge	9–24 days
Unfed larvae survive	up to 279 days
Unfed nymphs survive	up to 476 days
Unfed adults survive	up to 430 days

ECONOMIC IMPORTANCE

The long mouth parts, capable of deep penetration, make the bite of this tick painful to man and animals. Suppurating sores form at the site of attachment inside the ears and attract screwworms. Chickens are killed by massive infestations of tick larvae.

Amblyomma americanum is a carrier of the rickettsia, *Coxiella burneti,* causative agent of Q fever. Man and animals are infected by the feeding of ticks or by inhalation of contaminated dusts and infected tick feces. This tick is also a vector to man of Rocky Mountain spotted fever and tularemia. In the Eastern and Southern States, *A. americanum* reportedly causes tick paralysis in man and in dogs.

Amblyomma cajennense (Fabricius), the Cayenne tick

DISTRIBUTION

In the United States, *A. cajennense* is limited to several counties in southern Texas. This species is widespread throughout Mexico and Central America and is also found in the Caribbean area and in parts of South America. The tick derives its name from the locality, Cayenne, French Guiana, in which it was first collected.

HOSTS

All stages of this species attach to man as well as to livestock. Adults occur in great abundance on horses, mules, donkeys, cattle, dogs, and a variety of other animals. In many parts of tropical America, the larvae and nymphs are extremely abundant and aggressive in attacking man.

LOCATION ON HOST

Adult ticks prefer to attach between the legs or on the abdomen. However, in the equine, all stages of the tick are frequently found inside the ears and in other natural cavities, as well as on the flanks, withers, mane, and tail.

In cattle, the tick may be found attached to any part of the body. This species also has been found attached to the tongues of young calves.

SEASONAL ACTIVITY

All stages are found on hosts throughout the year in areas where this species is established.

LIFE CYCLE SUMMARY

The following life history information is adapted from Hooker, Bishopp, and Wood:

Amblyomma cajennense is a 3-host tick.

The female lays .....up to 7,700 eggs
Preoviposition period .....9–20 days
Oviposition period .....average 19.7 days
Incubation of eggs.....37–154 days
Larvae engorge .....3–7 days
Larvae molt .....approximately 10 days
Nymphs engorge .....3–13 days
Nymph molt .....12–105 days
Females engorge .....7–12 days
Unfed larvae survive.....57–386 days
Unfed nymphs survive..more than 13.5 months
Unfed adults survive .....up to 466 days

ECONOMIC IMPORTANCE

Amblyomma cajennense is a very serious pest of man and animals. In parts of South America, it is alleged to cause great damage to cattle by producing "fever," weakness, and death.

This species is a vector of spotted fever in Mexico, Panama, Colombia, and Brazil. Experimentally, this tick is capable of transmitting brucellosis. It is also reported to be capable of stage-to-stage transmission of Q fever and has been experimentally infected with *Trypanosoma cruzi.*

Amblyomma hebraeum Koch, the Bont tick

DISTRIBUTION

Amblyomma hebraeum is a native of southern Africa. It is found in the Republic of South Africa in the coastal areas east of Port Elizabeth, up through Natal and Zululand into the eastern and northern Transvaal; and in parts of Mozambique, Botswana, and Rhodesia. It thrives in a warm, moderately humid climate on the veld where tall grass and trees provide shade.

The bont tick has been found in the United States on several occasions, either on rhinoceroses offered for entry or on rhinoceroses which had recently been imported. For example, in June 1966, two rhinoceroses arrived at the port of Mobile, Ala., enroute to a zoological garden in California. They were trucked from Mobile prior to treatment. Veterinary Services inspectors at Laredo, Tex., learned that the animals had been held for feed, water, and rest in Laredo. They collected ticks which were later identified as *A. hebraeum.* Meanwhile, the truck proceeded to El Centro, Calif., where the rhinoroses were treated prior to proceeding to destination. The animals were heavily infested with *A. hebraeum* at the time of treatment.

HOSTS

Cattle and antelopes are the preferred hosts for the adult ticks but a variety of larger domesticated and wild mammals are attacked. The larvae and nymphs also feed on the larger mammals as well as on a number of smaller ones, particularly wild hares. The immature stages frequently feed on ground birds and even reptiles.

LOCATION ON HOST

The adults prefer bare areas of the body, especially under the tail, on the genitals, teats, udder, and in the groins and axillae. They are also found on the dewlap, brisket, and undersides of the abdomen. Larvae and nymphs attach anywhere on the body.

SEASONAL ACTIVITY

In South Africa, the adults are most abundant on hosts during the late summer and autumn months.

LIFE CYCLE SUMMARY

The following information is adapted from Lounsbury and from Nuttall:

Amblyomma hebraeum is a 3–host tick.

The female lays	10,000–20,000 eggs
Preoviposition period	2–11 weeks
Oviposition period	3–9 weeks
Incubation of eggs	11 weeks–6 months
Larvae engorge	4–9 days
Larvae molt	16 days–3 months
Nymphs engorge	4–8 days
Nymphs molt	18 days–11 weeks
Females engorge	6–10 days
Total	147 days–409 days
Unfed larvae survive	up to 346 days
Unfed nymphs survive	up to 250 days
Unfed adults survive	more than 660 days

In South Africa, at least 9 months are required to complete the life cycle under natural conditions; in exceptional circumstances 2 years or more may be required. Normally, however, one generation is completed each year.

ECONOMIC IMPORTANCE

The bont tick is a vector of *Cowdria ruminantium*, causative agent of heartwater in cattle, sheep, and goats. *Rickettsia conori*, which produces boutonneuse fever (tick typhus), has been isolated from this species and it is apparently a vector in the South African veld.

The long mouth parts of *A. hebraeum* enable it to produce deep-seated, painful wounds which often become infected and lead to abscess formation and infestation with blowfly larvae. When these ticks occur on the legs and between the toes of cattle and sheep, they may cause sores that result in lameness.

Amblyomma maculatum Koch, the Gulf Coast tick

DISTRIBUTION

In the United States, this tick is found primarily in the Southern States bordering the Gulf of Mexico and along the Atlantic coast. It is seldom established more than 200 miles inland. However, Veterinary Services personnel have found established infestations on sheep and cattle in several counties in northeastern Oklahoma. The tick has also been reported from Mexico and several countries in northern South America (Colombia, Ecuador, Venezuela).

HOSTS

The larvae and nymphs engorge primarily on ground-inhabiting birds, although they are also found on small mammals. Sheep, mules, horses, cattle, dogs, and deer are common hosts for adult ticks. Man is sometimes attacked by the adults.

LOCATION ON HOST

The larvae and nymphs are found primarily on the head and neck of birds, and on the head and ears of small mammals. The adults prefer to attach to the head, particularly the ears, of larger mammals, but in heavy infestations may also be found on other areas of the body.

SEASONAL ACTIVITY

The imature stages are found on birds throughout the year but are most abundant in the spring and summer. The adults are found on livestock in the greatest numbers during the late summer and early fall.

LIFE CYCLE SUMMARY

The following information is adapted from Hooker, Bishopp, and Wood; and Bishopp and Hixon:

Amblyomma maculatum is a 3–host tick.

The female lays	up to 18,000 eggs
Preoviposition period	3–9 days
Oviposition period	13–75 days
Incubation of the eggs	21–142 days
Larvae engorge	3–7 days
Larvae molt	7–121 days
Nymphs engorge	5–11 days
Nymphs molt	17–71 days
Females engorge	14–18 days
Unfed larvae survive	up to 179 days
Unfed nymphs survive somewhat longer than larvae	
Unfed adults survive	up to 411 days

Due to the limited seasonal activity of the adult stage, the Gulf Coast tick probably completes one life cycle per year under normal conditions.

ECONOMIC IMPORTANCE

The Gulf Coast tick has been incriminated as a producer of tick paralysis in man and dogs in the Southeastern United States.

This tick causes "tick worry" to domestic animals and massive infestations result in great loss of blood, debilitation, and even death. Heavy infestation of the ears often results in the development of a condition suitable for attack by the screwworm, *Cochliomyia hominivorax*.

Amblyomma variegatum (Fabricius), the Tropical Bont tick

DISTRIBUTION

The tropical bont tick is a native of Africa and is widely distributed in Eastern, Central, and Western Africa. It was introduced into the West Indies in the mid-to-late 1800's on cattle imported from Senegal and is now well established on St. Kitts, Guadeloupe, and Antigua.

In September 1967, *A. variegatum* was found established on St. Croix, U.S. Virgin Islands. An extensive program of inspection, dipping, and ground spraying was carried out, and by May 1970, the tropical bont tick had been eliminated from St. Croix.

In June 1974, *A. variegatum* was confirmed as being established in Puerto Rico. Subsequent investigations revealed the presence of the tropical bont tick on at least 26 premises in the area of Cidra and Cayey, some 25 miles south of San Juan.

HOSTS

The common hosts for adult ticks include cattle, sheep, horses, goats, antelopes, camels, and a long list of large wild mammals. Man has also been reported as a host for the adult stage. Nymphs feed on a great variety of mammals of medium and large size, occasionally including man. Birds are frequently attacked by the nymphs. The larvae may feed on any of these hosts but prefer smaller mammals and birds.

LOCATION ON HOST

The adult ticks are commonly found on the lower part of the dewlap, brisket, axillae, abdomen, groins, escutcheon, udder, and external genitalia of the male. They may also be found on or near the vulva, under the tail, and in the interdigital cleft. The immature stages are more likely to attach anywhere on the host.

SEASONAL ACTIVITY

The following information is taken from Hoogstraal *(1956)* and applies to the Sudan:

"Adults appear towards the end of the dry season, first males and then females. Populations increase in numbers and remain high through the rainy season and decrease rapidly in the dry season, although a few specimens may be found even then. Larvae and nymphs gradually become more numerous in the dry season, and while some nymphs are found during the rains they are scarce."

LIFE CYCLE SUMMARY

The following information is adapted chiefly from Walker in Hoogstraal:

Amblyomma variegatum is a 3-host tick.

The female	
lays	approximately 10,000–12,000 eggs
Preoviposition period	12 days
Oviposition to hatching	53 days
Larval prefeeding period	7 days
Larva feeds	5 days
Premolting period	14 days
Nymphal prefeeding period	7 days
Nymph feeds	5 days
Premolting period	19 days
Adult prefeeding period	7 days
Female feeds	12 days
Total	141 days

In areas with one rainy season each year, only one life cycle is completed per year; in areas with two rainy periods, two generations may be expected each year.

ECONOMIC IMPORTANCE

Amblyomma variegatum is a common vector of *Cowdria ruminantium* which produces heartwater in cattle, sheep, and goats. This species is also a vector of Nairobi sheep disease.

Apparently *A. variegatum* plays a role in the natural spread of dermatophilosis (bovine streptothricosis), which is generally accepted to be produced by *Dermatophilus congolensis.* Epidemiological evidence indicates that there is a relationship between the tropical bont tick and the development of the disease. In the laboratory, dermatophilosis has been transmitted from cattle to rabbits by adults of *A. variegatum.*

The bite of the adult tropical bont tick is especially serious since the mouth parts penetrate very deep, resulting in the formation of wounds and abscesses. Severe lameness may be caused by the attachment of the ticks in the interdigital clefts. A definite reduction in the value of hides and skins is caused by heavy infestations of *A. variegatum.*

In some areas the larvae are a serious pest of man and attach on the legs and around the waist. Larvae reportedly may burrow under the skin and cause intense irritation and inflammation. The causative agents of Q fever, caused by *Coxiella burneti,* and boutonneuse fever (tick typhus), caused by *Rickettsia conori,* have been isolated from *A. variegatum.*

Argas persicus (Oken), the Fowl tick

DISTRIBUTION

Argas persicus is primarily an Old World species. Careful study [10] of specimens from the New World believed to be *A. persicus* showed that this tick plus three other closely related but distinct, valid species are present. The other species are *A. radiatus* reported from Florida, Iowa, Texas, and Mexico; *A. sanchezi* reported from Arizona, California, Nevada, New Mexico, Texas, Utah, and Mexico; and *A. miniatus* reported from Panama, Trinidad, Colombia, Brazil, and possibly the United States (Georgia). Apparently *A. persicus* is rather rare in the New World with very limited collections reported from Maryland, Pennsylvania, Georgia, California, and Paraguay.

In this manual the name *Argas persicus* group is used collectively when referring to the above-named species, although it is recognized that *A. persicus* is probably not the common species encountered in the United States. There is confusion regarding the validity of older published material on the distribution, hosts, identification, and biology of the *Argas* ticks. Quite likely many of the older published references to *A. persicus* in the Southwestern United States were misidentifications of *A. radiatus* and *A. sanchezi.* All conditions being equal, the biology of these species is probably very similar.

[10] See Kohls, Hoogstraal, Clifford and Kaiser (1970).

HOSTS

In the New World the true *A. persicus* and *A. miniatus* have been collected only from chickens or chicken houses. *Argas radiatus,* and *A. sanchezi* parasitize poultry and various wild avian hosts.

LOCATION ON HOST

The fowl tick attaches beneath the wings and other places where feathers are sparse.

SEASONAL ACTIVITY

The fowl tick occurs in greatest abundance on birds during the warmer, drier seasons of the year.

LIFE CYCLE SUMMARY

The following information is chiefly adapted from Hooker, Bishopp, and Wood:

Argas persicus is a multihost tick.

The female may lay as many as 874 eggs during her entire life. These are produced in as many as seven batches with a blood meal proceeding each batch of eggs. The maximum number of eggs in the first batch is 195 with a peak of 245 eggs with the third batch. Only 47 eggs were reported from the seventh oviposition.

Preoviposition period..2 days to several months
Oviposition period .....in summer usually 4 to 10 days;
Incubation of the eggs..in summer, usually 8–11 days; in winter, up to 107 days
Larvae engorge.....2–10 days
Larvae molt.....4–17 days
Nymphs (1st, 2nd, and 3rd stage) engorge.....approx. 30 min.–2 hours
1st stage nymphs molt..... 7 to 28 days
2nd stage nymphs molt..in summer, 11–24 days; in winter, up to 195 days
3rd stage nymphs molt.....9–12 days
Females may engorge as many as 7 times and feed each time for approx.....30 min.–2 hrs...
Unfed larvae survive.....in cool weather, up to 164 days; in mid summer, about 60 days
Nymphs survive..up to 509 days for 2nd stage
Unfed Adults survive..up to 2 years and 5 mos. (Some authors report longer periods.)

ECONOMIC IMPORTANCE

These ticks may inflict extensive skin damage and produce large blood clots on their natural hosts during feeding. Light infestations cause emaciation, weakness, slow growth, and lowered egg production. Heavy infestations cause exsanguination and death of the host. Turkeys and newly hatched poults and chicks show the greatest mortality. Birds are attacked more freqeuntly during the warmer, drier seasons of the year.

Argas persicus is the chief vector of *Borrelia anserina,* causative agent of a highly fatal spirochetosis in chickens, turkeys, pheasants, doves, and pigeons. It also transmits *Aegyptianella pullorum* which produces fowl piroplasmosis in chickens and geese.

Gothe reported tick paralysis in chickens infested with the South African strain of *A. persicus.*

The authors observed tick paralysis in a southern Maryland flock of chickens infested with *A. persicus;* 85 percent of the birds died within 1 month of being placed in the infested chicken house.

While *A. persicus* is not known to transmit any human diseases naturally, its bite has been reported to cause severe pain. The true *A. persicus* rarely attacks man and other mammals.

Boophilus annulatus (Say), the Cattle Fever tick

DISTRIBUTION

At the beginning of the 1900's the cattle-fever tick was widely distributed throughout the Southern United States. The species is now eradicated from the United States except for periodic introductions on illegal movements or stray cattle from Mexico where *Boophilus annulatus* is still prevalent. This species is also found in western and central Africa, and the Sudan. If *B. calcaratus* is synonomous with *B. annulatus,* the range is extended to the Mediterranean basin and the Near East.

HOSTS

Cattle are preferred hosts; horses are next in preference; and sheep and goats are rarely attacked. Under certain conditions deer may serve as suitable hosts. Attachment to man and dog has been reported, but neither is considered to be a satisfactory host for the development of *B. annulatus.*

LOCATION ON HOST

The cattle fever tick prefers to attach on the dewlap, brisket, neck, axillae, abdomen, groins, escutcheon, and the genitalia. Larvae and nymphs may be found in the ears. In severe infestations ticks may be found any place on the body.

SEASONAL ACTIVITY

In the lower portion of the Southern States, prior to eradication, all parasitic stages were found on livestock throughout the year. However, in both the upper and lower Southern States *B. annulatus* was most abundant on livestock during the spring, summer, and early fall.

LIFE CYCLE SUMMARY

The information given below is adapted from the following sources: Hunter and Hooker; Hooker, Bishopp, and Wood; Bishopp; and Graybill.

Boophilus annulatus is a 1–host tick.

The female lays	as many as 4,500 eggs
Preoviposition period	2–66 days
Oviposition period	6–70 days
Incubation of the eggs	19–202 days
Larvae engorge and molt	5–16 days
Nymphs engorge and molt	5–18 days
Females engorge	4–14 days
Unfed larvae survive	up to 246 days

The minimum parasitic period (from the attachment of larvae to dropping of engorged females) is 20 days; the maximum parasitic period is 59 days; and the average is 32 days.

The nonparasitic period (from the dropping of the engorged female to death of the last larva) may be as short as 28 days in the summer or extend up to 288 days, particularly if the engorged female drops in late summer or early fall.

Under very favorable conditions, particularly in the southern part of the old cattle fever tick infested area, as many as three or four generations of *B. annulatus* are possible each year. Fewer generations are capable of being produced each year in the northern part of the old cattle-fever tick zone because of the lower temperature.

ECONOMIC IMPORTANCE

This tick was once the most important external parasite of cattle in the Southern States. It caused serious economic loss by transmitting *Babesia bigemina,* causal protozoan of cattle fever (bovine piroplasmosis). The fever not only caused death in cattle but secondary losses also included: (1) weakened condition and stunted growth, (2) death due to gross tick infestation, (3) losses of potential markets by both northern and southern cattle breeders, (4) restriction on movement of southern cattle, (5) lowered milk production, (6) damage to hides and skins, (7) cost of maintaining quarantine line and facilities, (8) expenses incurred in attempt to reduce or eliminate ticks, and (9) infested animals predisposed to attacks by screwworms in Texas. In 1907, the primary and secondary losses due to *Boophilus* ticks in the United States were estimated to be $100 million each year.

The cattle fever tick has been incriminated in the transmission of bovine anaplasmosis. Experimentally, this species has transmitted, via its egg, the spirochete, *Borrelia theileri,* causative agent of spirochetosis in cattle, sheep, goats, and horses. Also, experimentally, this species has transmitted *Theileria mutans,* which causes benign bovine theileriosis.

Boophilus decoloratus (Koch), the Blue tick

DISTRIBUTION

The blue tick is widely distributed in western, central, eastern, and southern Africa.

HOSTS

Cattle are the chief hosts; horses are the second preference, with sheep and goats less frequently parasitized. Antelopes are the most important wild hosts.

LOCATION OF HOST

The blue tick is commonly found on the dewlap, brisket, neck, axillae, udder, groins, scrotum, and escutcheon. Larvae and nymphs are often found on the distal half of the ear flap. In heavy infestations ticks may be scattered over most of the body.

SEASONAL ACTIVITY

The blue tick is usually found on hosts throughout the year, with the greatest abundance and activity occurring during the warmer months.

LIFE CYCLE SUMMARY

The following information is adapted from Lounsbury in Theiler and du Toit and Theiler.

Boophilus decoloratus is a 1–host tick.

The female lays.....up to 2,500 eggs
Preoviposition period.....6–9 days
Oviposition and incubation period...3–6 weeks
Larvae engorge and molt.....7 days
Nymphs engorge and molt.....7 days
Females engorge.....7–9 days

In South Africa, the engorged female usually drops from the host 21–23 days after attaching as the larva.

ECONOMIC IMPORTANCE

The blue tick is one of the most common ticks attacking cattle in parts of Africa. It is an important transmitter of the following diseases: bovine piroplasmosis *(Babesia bigemina* and *B. bovis),* anaplasmosis *(Anaplasma marginale* and *A. centrale),* and spirochetosis *(Borrelia theileri)* of cattle, sheep, and goats. In addition to transmitting the above diseases, cattle are often heavily infested with blue ticks resulting in severe anemia, weakness, and death due to blood loss.

Boophilus microplus (Canestrini), The Tropical Cattle tick

DISTRIBUTION

Boophilus microplus is found in the hotter, more humid parts of the West Indies, Mexico, Central America, South America, Africa, Australia, the Orient, and Micronesia. At one time it was also established in southern Florida and in several counties in extreme southern Texas.

HOSTS

Apparently *B. microplus* has a slightly wider host preference than *B. annulatus.* The primary hosts for *B. microplus* are cattle, with horses as the second preference. It is found more commonly on goats, sheep, and deer than is *B. annulatus.*

LOCATION ON HOST

On the primary host, this tick is commonly found on the dewlap, brisket, neck, axillae, groins, abdomen, escutcheon, and the genitalia. Larvae and nymphs sometimes may be found in the ears.

SEASONAL ACTIVITY

Larvae, nymphs, and adults may be found on the host through the year in tropical and subtropical areas.

LIFE CYCLE SUMMARY

The following information is adapted from several sources including Tate; Hooker, Bishop, and Wood; Hitchcock; and Legg:

Boophilus microplus is a 1–host tick.

The female lays.....as many as 4,400 eggs
Preoviposition period.....2–39 days
Oviposition period.....4–44 days
Incubation of the eggs.....14–146 days
Larvae engorge and molt.....7–12 days
Nymphs engorge and molt.....5–17 days
Females engorge.....5–23 days
Unfed larvae survive.....up to 240 days

In Puerto Rico, the minimum parasitic period (from the attachment of larvae to dropping of engorged females) is 18 days; the maximum parasitic period is 37 days; but the greater number of females engorge and drop by the 25th day. The length of the life cycle may range from 41 to 300 days. Under favorable tropical conditions, *B. microplus* may produce more than four generations each year.

ECONOMIC IMPORTANCE

Boophilus microplus is a reported vector of the following agents: *Babesia bigemina* and *B. argentina,* which cause piroplasmosis in cattle,

Anaplasma marginale, which produces bovine anaplasmosis; and *Theileria mutans,* causative agent of benign bovine theileriosis.

Dermacentor albipictus (Packard), the Winter tick

DISTRIBUTION

This tick is widely but unevenly distributed in the northern tier of States from Maine to Oregon and throughout the Western States south into Texas and Mexico. It is also widely distributed in Canada.

HOSTS

The common hosts for *D. albipictus* include horses, cattle, deer, elk, and moose.

LOCATION ON HOST

This tick prefers to attach on the dewlap, brisket, abdomen, groins, and axillae but may be found attached all over the body in heavy infestations.

SEASONAL ACTIVITY

As the name indicates, *D. albipictus* is a winter tick; it occurs on livestock from autumn until early spring.

LIFE CYCLE SUMMARY

The following information is adapted from Bishopp and Wood:

Dermacentor albipictus is a 1-host tick.

The female lays	as many as 4,400 eggs
Preoviposition period	7–134 days
Oviposition period	19–42 days
Incubation of the eggs	33–71 days
Larvae engorge and molt	9–20 days
Nymphs engorge and molt	usually 9–12 days
Females engorge	8–30 days
Unfed larvae survive	up to 346 days

On livestock, the parasitic period ranges from approximately 28 to 60 days. The nonparasitic period (from the dropping off of the engorged female to death of last larva) ranges from 159 to at least 479 days. Under natural conditions the winter tick produces one generation a year.

ECONOMIC IMPORTANCE

Heavy infestations of the winter tick inflict severe losses among deer, elk, and moose. Animals become weakened and often die as a result of the parasitism. Cattle, and especially horses, may also be seriously affected by attacks of this tick.

Under experimental conditions *D. albipictus* is a vector of *Anaplasma marginale,* which produces bovine anaplasmosis.

Dermacentor andersoni Stiles *Synonym, Dermacentor* ventustus Banks, the Rocky Mountain wood tick

DISTRIBUTION

This tick is found from the western counties of Nebraska and the Black Hills of South Dakota to the Cascade and Sierra Nevada Mountains, and from northern Arizona and northern New Mexico to British Columbia, Alberta, and Saskatchewan, Canada.

HOSTS

Important hosts for the adult stage include cattle, horses, deer, dogs, man, elk, and several other large mammals. The immature stages prefer many small mammals such as chipmunks, ground squirrels, meadow mice, woodchucks, and rabbits.

LOCATION ON HOST

The adults prefer to attach on the head, neck, shoulders, dewlap, brisket, groins, and escutcheon. Immature stages usually attach around the head, neck, and shoulders of small mammals.

SEASONAL ACTIVITY

Adults usually begin showing up on hosts in February or March, reach a maximum abundance during April and May, and decline in numbers by July. Immatures occur somewhat later than do the adults; nymphs appear on hosts early in April; larvae appear on hosts early in June; and both disappear from hosts by late summer.

LIFE CYCLE SUMMARY

The following information is adapted from Hunter and Bishopp; and Hooker, Bishopp, and Wood:

Dermacentor andersoni is a 3–host tick.

The female lays	as many as 7,400 eggs
Preoviposition period	6–41 days
Oviposition period	15–32 days
Incubation of the eggs	15–51 days
Larvae engorge	2–8 days
Larvae molt	6–21 days
Nymphs engorge	3–9 days
Nymphs molt	usually 11–19 days
Females engorge	8–17 days
Unfed larvae survive	up to 117 days
Unfed nymphs survive	over 300 days
Unfed adults survive	up to about 600 days

The normal life cycle requires 1 or 2 years for completion, with the 1–year cycle being common where small mammals are abundant. A 3–year cycle may exist at high altitude and at the northern limits of the tick's range.

ECONOMIC IMPORTANCE

In the Northwestern United States, *D. andersoni* is very important as a parasite of man and livestock. It is the primary vector of *Rickettsia rickettsi,* disease agent of Rocky Mountain spotted fever, and it is also the chief producer of tick paralysis in man and animals. Other diseases transmitted or carried by this tick include Colorado tick fever of man, tularemia, and Q fever.

Bovine anaplasmosis is an important livestock disease suspected of being transmitted by *D. andersoni* in the Northwestern States.

Causative agents of other diseases such as canine piroplasmosis and arthropod-borne encephalitis (Western type) have been experimentally transmitted by *D. andersoni,* but there is no evidence to indicate that disease transmission is a problem under natural conditions.

Dermacentor nitens Neumann
Synonym, *Anocentor nitens* (Neumann), the Tropical Horse tick

DISTRIBUTION

In the United States, the tropical horse tick is established only in southern Florida and several counties in the extreme tip of southern Texas. This tick is also common in Mexico, Central America, the West Indies, and northern South America.

HOSTS

The horse and other domesticated equines are the preferred hosts, but it also occurs on cattle, deer, sheep, and goats.

LOCATION ON HOST

The ears are the preferred site of attachment for the tropical horse tick. This tick is unusual because the larvae, nymphs, and adults all occur in the ears. Ticks also attach in the nasal diverticula, perianal area, groins, mane, and on the abdomen. In heavy infestations, ticks may be found all over the body.

SEASONAL ACTIVITY

All parasitic stages may be found on the host throughout the year in enzootic areas.

LIFE CYCLE SUMMARY

The following information is adapted from Hooker, Bishopp, and Wood; and Tate:

Dermacentor nitens is a 1–host tick.

The female lays	as many as 3,400 eggs
Preoviposition period	3–15 days
Oviposition period	15–37 days
Incubation of the eggs	21–28 days
Larvae engorge and molt	8–16 days
Nymphs engorge and molt	approx. 7–14 days
Females engorge	9–23 days
Unfed larvae survive	up to 71 days

The minimum parasitic period reported is 26 days; the maximum parasitic period is 41 days; but the majority of the females probably engorge and drop well before the maximum period is reached. Under favorable tropical conditions several generations are completed each year.

ECONOMIC IMPORTANCE

Dermacentor nitens is a vector of *Babesia caballi,* one of the organisms which causes equine piroplasmosis.

This tick is a serious pest of horses in tropical and subtropical areas where it is established. The ears may literally become filled with ticks, molted skins, and excrement which develop a very offensive odor. Infection and suppuration often follow and predispose the animal to attack by the screwworm, *Cochliomyia hominivorax.* Massive infestations of *D. nitens* can cause anemia, loss of weight, and even death.

Dermacentor occidentalis Marx, the Pacific Coast tick

DISTRIBUTION

As the common name implies, *D. occidentalis* is confined to the Pacific Coast. It is established in and to the west of the Cascade Range and Sierra Nevada Mountains in Oregon and California. It has also been found in northern Baja California, Mexico.

HOSTS

The common hosts for the adult stage include cattle, horses, deer, dog, sheep, and man. Immature ticks are found on a variety of smaller mammals such as chipmunks, ground squirrels, field mice, and wood rats.

LOCATION ON HOST

The adult is the only stage commonly found on livestock and it may be found distributed over the host's body.

SEASONAL ACTIVITY

The larvae and nymphs are most abundant on hosts in the spring and summer. Adults have been taken from livestock throughout the year but seem to reach a peak of abundance in April and May.

LIFE CYCLE SUMMARY

The following information is adapted from Hooker, Bishopp, and Wood:

Dermacentor occidentalis is a 3–host tick.

The female lays	up to 4,500 eggs
Preoviposition period	4–17 days
Oviposition period	approx. 14 days
Incubation of the eggs	16–38 days
Larvae engorge	3–7 days
Larvae molt	6–12 days
Nymphs engorge	4–9 days
Nymphs molt	13–22 days
Females engorge	6–17 days
Unfed larvae survive	up to 124 days
Unfed nymphs survive	up to 108 days
Unfed adults survive	up to 359 days

ECONOMIC IMPORTANCE

This tick apparently plays a role in the maintenance and spread of bovine anaplasmosis. In California, it has also been found associated with cases of tick paralysis in livestock.

Dermacentor occidentalis is capable of transmitting the causative agents of tularemia and Rocky Mountain spotted fever, and it has been found naturally infected with the virus of Colorado tick fever and the rickettsia of Q fever.

Dermacentor variabilis (Say), the American dog tick

DISTRIBUTION

This tick is widely distributed over the eastern half of the United States, and in parts of California, Idaho, Oregon, Washington, and Montana. It is also established in areas of Canada and Mexico.

HOSTS

The common hosts for the adult stage include man, dogs, cattle, horses, deer, and many other wild and domesticated mammals. The immature stages engorge mainly on small rodents, especially meadow mice.

LOCATION ON HOST

Adults seem to prefer to attach on the neck, dewlap, brisket, axillae, groins, genitalia, abdomen, and escutcheon. In massive infestations they may be found all over the body. Immature stages feed mainly around the head, neck, and shoulders of small mammals.

SEASONAL ACTIVITY

In the Central and Northern States, adult activity begins around mid-April, peaks in June, and thereafter declines until September. In the Southern States, ticks in all stages may be found on hosts throughout the year, although they are usually more abundant in the spring.

LIFE CYCLE SUMMARY

The following information is adapted from Smith, Cole, and Gouck; and Bishopp and Smith:

Dermacentor variabilis is a 3–host tick.

The female lays.....approximately 6,500 eggs
Preoviposition period.....3–58 days
Oviposition period.....14–32 days
Incubation of the eggs.....26–57 days
Larvae engorge.....3–13 days
Larvae molt.....6–247 days
Nymphs engorge.....3–11 days
Nymphs molt.....24–291 days
Females engorge.....5–27 days
Unfed larvae survive.....up to 540 days
Unfed nymphs survive.....up to 584 days
Unfed adults survive.....up to 1,053 days

In the Southern States, the life cycle may possibly be completed in 1 year, but in the Northern States the 2–year cycle may be more common.

ECONOMIC IMPORTANCE

Dermacentor variabilis is the principal vector of *Rickettsia rickettsi,* the causative organism of Rocky Mountain spotted fever of man, from the Mississippi Valley east to the Atlantic Ocean and south to the Gulf of Mexico, including Texas and Oklahoma. This tick also produces tick paralysis in man and dogs.

The American dog tick transmits the disease agent of tularemia and it is partially responsible for the maintenance of infection in rodents in nature. Stage-to-stage, but not transovarial, transmission of bovine anaplasmosis *(Anaplasma marginale)* has been demonstrated with this tick.

Haemaphysalis leachi leachi [11] (Audouin), the Yellow dog tick

DISTRIBUTION

The yellow dog tick is distributed throughout the Ethiopian zoo-geographical realm, except in desert areas receiving less than 20 inches rainfall annually.

HOSTS

The dog is the primary host for the adults of *H. l. leachi,* but they may also be found on cats and the larger wild carnivores. Immatures usually parasitize field rodents but may feed on domestic dogs.

LOCATION ON HOST

The neck and shoulders are the preferred attachment sites.

SEASONAL ACTIVITY

Haemaphysalis l. leachi is most abundant on hosts during the warmer seasons of the year.

LIFE CYCLE SUMMARY

The following information is adapted from Theiler; and Nuttall:

Haemaphysalis l. leachi is a 3–host tick.
The female lays.....up to 4,800 eggs
Preoviposition period.....3–7 days
Incubation of the eggs.....26–37 days

[11] The subspecies *Haemaphysalis leachi muhsami* Santos Dias is also widely distributed in Africa. It is smaller in size and prefers to feed on small carnivores, such as mongooses, and wildcats, instead of on wild or domestic canines. Disease relationship of *H. l. muhsami* are unstudied.

Larvae engorge.....2–7 days
Larvae molt.....about 30 days
Nymphs engorge.....2–7 days
Nymphs molt.....10–16 days
Females engorge.....4–16 days
Egg to egg.....81–120 days
Unfed larvae may survive..6 months or longer
Unfed nymphs may survive..2 months or longer
Unfed adults may survive..7 months or longer

In nature, the yellow dog tick apparently produces two generations each year.

ECONOMIC IMPORTANCE

The yellow dog tick transovarially transmits *Babesia canis* (canine piroplasmosis). Like many other ticks, it has been found naturally infected with *Coxiella burneti,* which causes Q fever.

In South Africa, urban cases of boutonneuse fever are associated with dogs infested with adults of *H. l. leachi.* Human infection is often acquired by contamination of the skin and eyes with *Rickettsia conori* from yellow dog ticks which are crushed as they are picked off dogs.

Haemaphysalis leporispalustris (Packard), the Rabbit tick

DISTRIBUTION

This tick is widely distributed in North America, from Alaska and Canada southward into Mexico. It has also been reported from parts of Central and South America.

HOSTS

Rabbits are the preferred hosts for the adult stage of this tick. Birds of many kinds, especially ground-inhabiting birds, and small mammals serve as hosts for the immature stages. Veterinary Services personnel have also taken several collections of nymphs from cattle and deer.

LOCATION ON HOST

On rabbits, the ticks usually attach to the ears, around the eyes, and on other parts of the head. The favorite attachment sites on birds are the top and back of the head and around the eyes and ears.

SEASONAL ACTIVITY

In the Southern States, *H. leporispalustris* may be found on hosts throughout the year, but is more abundant on hosts in spring and fall. In the Northern States, this tick is usually not found on hosts during the winter, and is most abundant during the spring and summer and declines in the fall.

LIFE CYCLE SUMMARY

The following information is adapted from Hooker, Bishopp, and Wood; and Rohr and Hadwen in Nuttall and Warburton:

Haemaphysalis leporispalustris is a 3–host tick.

The female lays.....up to 2,400 eggs
Preoviposition period.....2–18 days
Oviposition period.....3–57 days
Incubation period.....22–61 days
Larvae engorge.....4–11 days
Larvae molt.....18–134 days
Nymphs engorge.....4–11 days
Nymphs molt.....14–124 days
Females engorge.....19–25 days
Unfed larvae survive.....up to 258 days
Unfed nymphs survive.....up to 342 days
Unfed adults survive.....up to 588 days

In the Southern States, under favorable conditions, as many as two complete life cycles may be completed each year.

ECONOMIC IMPORTANCE

The rabbit tick rarely attacks livestock and man. It is a common parasite of rabbits and birds and massive infestations often weaken and kill them.

This tick plays an especially important role in the maintenance and spread of Rocky Mountain spotted fever and tularemia among wild animals. *Haemaphysalis leporispalustris* is a carrier of *Coxiella burneti,* causative agent of Q fever.

Hyalomma marginatum Koch, the Mediterranean *Hyalomma*

DISTRIBUTION

The ticks generally accepted as being *Hyalomma marginatum* represent a complex of

several subspecies [12] that are found in southern Europe, southern Russia, north Africa, the Middle East, and in scattered areas of other parts of Africa and Asia.

HOSTS

Common hosts for the adults are cattle, horses, sheep, goats, and camels. Nymphs also feed on domestic animals but are more common on small wild mammals and birds. Larvae feed only on small animals.

LOCATION ON HOST

These ticks are commonly found in the perianal area, groins, on the genitalia and udder, axillae, and on the brisket and dewlap.

SEASONAL ACTIVITY

The adults are found on hosts most frequently in the spring and summer; the larvae and nymphs are usually found on hosts in the summer.

LIFE CYCLE SUMMARY

The following information is adapted from Nuttall (1913).[13]

Hyalomma marginatum may act as a 2–host or 3–host tick.

Female lays	up to 15,500 eggs
Preoviposition period	6–12 days
Oviposition to hatching	35 days
Larval prefeeding period	7 days
Larvae feed	6 days
Larvae molt	16 days
Nymphal prefeeding period	7 days
Nymphs feed	6 days
Nymphs molt	20 days
Adult prefeeding period	7 days
Female feeds	6 days
Total	116 days
Unfed larvae survive	up to 345 days
Unfed nymphs survive	up to 89 days
Unfed adults survive	over 421 days

[12] Hoogstraal and Kaiser recognize several subspecies of *H. marginatum*, namely *H. marginatum marginatum*, *H. marginatum rufipes*, *H. marginatum isaaci*, and *H. marginatum turanicum*.

[13] Hoogstraal reports that the life cycle studies of *H. aegyptium* conducted by Nuttall were undertaken with specimens now recognized as *H. marginatum*.

Apparently one generation is normally produced each year.

ECONOMIC IMPORTANCE

As a group, the genus *Hyalomma* is of considerable veterinary and medical importance as vectors and reservoirs of disease-producing agents. The ticks of the *Hyalomma marginatum* group are reportedly vectors of the disease-producing agents of bovine theileriosis (*Theileria* spp.), equine piroplasmosis (*Babesia caballi* and *B. equi*), and canine piroplasmosis (*B. canis*). In man, some of these ticks are vectors of the virus of Crimean hemorrhagic fever, Q fever (*Coxiella burneti*), and boutonneuse fever (*Rickettsia conori*) and are also incriminated in the maintenance and spread of brucellosis (*Brucella melitensis*).

Hyalomma ticks, other than the *H. marginatum* group, are also involved in the transmission of other disease-producing agents. For example, some strains of *H. truncatum* are known to be involved in the production of sweating sickness in cattle, sheep, and goats in parts of southern Africa. Other species of *Hyalomma* are reportedly able to transmit the causative agents of bovine anaplasmosis (*Anaplasma marginale*) and bovine ehrlichiosis (*Ehrlichia bovis*).

Ixodes ricinus (Linnaeus), the European Castor Bean tick

DISTRIBUTION

This tick is common throughout most of Europe, including the British Isles, and is found in north Africa (Tunisia and Algeria) and limited areas of Asia. Contrary to earlier reports, this tick has never been established in North America.

HOSTS

Common hosts for the adults include sheep, cattle, dogs, horses, and deer; immatures have been reported from various birds and even lizards.

LOCATION ON HOST

This tick prefers to attach on areas where the hair is short or the skin is bare, such as the face, ears, axillae, groins, and escutcheon.

SEASONAL ACTIVITY

In northern areas this species is found on hosts in the summer. In milder temperate regions of Eurasia it may have two activity periods, spring and autumn. In Algeria and Tunisia it is a winter tick.

LIFE CYCLE SUMMARY

The following information is adapted from Nuttall (1911):

Ixodes ricinus is a 3–host tick.

The female lays	up to 3,000 eggs
Preoviposition period	8–27 days
Oviposition and incubation of the eggs	42–252 days
Larval prefeeding period	10–570 days
Larvae engorge	3–6 days
Larvae molt	28–140 days
Nymphal prefeeding period	10–540 days
Nymphs engorge	3–5 days
Nymphs molt	56–360 days
Adult prefeeding period	10–810 days
Females engorge	8–14 days
Total	178–2,724 days
Unfed larvae survive	up to 19 months
Unfed nymphs survive	up to 18 months
Unfed adults survive	up to 27 months

As long as 3 years is normally required to complete the life cycle; the larvae feed the first year, the nymphs the second year, and the adults the third year. Under very favorable conditions the life cycle may be completed in less than 3 years.

ECONOMIC IMPORTANCE

In Europe, this species is responsible for transmitting bovine piroplasmosis *(Babesia bovis)*, anaplasmosis *(Anaplasma marginale)*, the virus of louping ill, and tick-borne fever *(Ehrlichia phagocytophila)* of cattle, sheep, and goats. It has been found naturally infected with the causative agent *(Coxiella burneti)* of Q fever.

In Great Britain, *I. ricinus* is associated with the production of tick pyemia *(Staphylococcus aureus)* in young lambs. Although the ticks are not thought to transmit the bacteria, the wounds produced by its feeding permit the organism to gain entrance readily into various parts of the body and produce abscesses.

In European Russia and parts of northern and central Europe, *I. ricinus* is the vector of the virus which causes tickborne encephalitis in man.

Ixodes scapularis (Say), Black–legged tick

DISTRIBUTION

This tick is common in the Southeastern States, Texas, eastern Oklahoma, and along the Atlantic coast to Massachusetts. Recently it was found in Wisconsin and Minnesota. It also extends into Mexico.

HOSTS

The adults prefer to feed on larger mammals such as cattle, horses, deer, dogs, sheep, hogs, and man. Larvae and nymphs feed primarily on birds, small mammals, and occasionally lizards.

LOCATION ON HOST

The adults usually attach on the head and neck of dogs and other larger mammals.

SEASONAL ACTIVITY

The adults are more abundant on hosts from late fall to spring; immature stages are more abundant on hosts in the spring and summer.

LIFE CYCLE SUMMARY

The following information is adapted from Hooker, Bishopp, and Wood; and Harris:

Ixodes scapularis is a 3–host tick.

The female lays	approximately 3,000 eggs
Preoviposition period	10–19 days
Incubation of the eggs	48–135 days
Larvae engorge	3–9 days
Larvae molt	22–49 days
Nymphs engorge	3–8 days
Nymphs molt	25–56 days
Females engorge	8–9 days
Unfed larvae survive	more than 75 days
Unfed nymphs survive	more than 60 days
Unfed adults survive	undetermined

Under normal conditions, the black-legged tick apparently completes one life cycle each year.

ECONOMIC IMPORTANCE

At the present time, *I. scapularis* is not known to be involved in the natural transmission of disease agents of livestock and man.[14] Experimentally, stage-to-stage transmission of *Anaplasma marginale* has been reported. Ticks have been found naturally infected with *Francisella tularensis* and experimental transmission of tularemia has been reported.

Ornithodoros coriaceus Koch, the Pajaroello tick

DISTRIBUTION

This tick occurs along the Pacific Coast of California from Humboldt County in the north to San Diego County in the south. It is also believed to occur along the coast of Mexico as far south as the State of Chiapas.

HOSTS

Common hosts are cattle and deer. It also feeds on man and probably on a variety of other mammals.

LOCATION ON HOST

The nymphs and adults remain in protected areas under trees in old deer- and cattle-bedding grounds and attack livestock, wildlife, and man when they pause in these locations. The ticks probably feed most readily on an accessible area, most likely the legs and ventral portions of the body.

SEASONAL ACTIVITY

In some areas this tick is active throughout the year, but in other locations it is active only in the warmer months.

LIFE CYCLE SUMMARY

The following information is adapted from Loomis; Herms; and Smith.
Ornithodoros coriaceus is a multihost tick.

The female tick can lay over 2,000 eggs in her productive life of 3 or more years.

Preoviposition period	15–55 days
Incubation of the eggs	23–40 days
Larval prefeeding period	3–7 days
Larval feeding	7–10 days
Larval molt	10–28 days
First nymphal stage does not feed	
First nymphal molt	8–39 days
Second nymphal molt[15]	14–30 days
Third nymphal molt	10–60 days
Fourth nymphal molt	16–74 days
Fifth nymphal molt	28–92 days
Sixth nymphal molt	35–114 days
Seventh nymphal molt	33–53 days
Adult feeding[16]	15–30 minutes
Total days for complete cycle	202–602
Unfed adults survive for about	9 months
Fed males survive about	3 years and 7 months
Fed females survive for	more than 5 years

The length of the cycle is influenced by the temperature and availability of hosts. Under natural conditions there is probably one generation each year, but in many instances, a generation may take 2 years to develop.

ECONOMIC IMPORTANCE

The pajaroello tick readily attacks man and livestock and its venomous "bite" is reported to be very painful.

Although this species is not known to transmit any disease, it should not be ruled out as a potential vector until adequate research has been conducted.

Otobius megnini (Dugès), the Spinose ear tick

DISTRIBUTION

The spinose ear tick is a native of the Americas and is very abundant in the Southwestern and Western United States and Mexico. It has been carried to other areas of the world

[14] Recent reports incriminate *I. scapularis* as a possible vector of piroplasmosis *(Babesia microti)* in humans on Nantucket Island, Massachusetts. *Babesia microti* is a parasite of field mice and deer mice.

[15] Each nymphal stage, except for the first, generally feeds for 15–30 minutes.

[16] The adults normally feed several times over an extended period and the female usually lays a batch of eggs after each feeding.

in the ears of the hosts. *Otobius megnini* is now established in parts of Africa, Madagascar, India, and Hawaii, as well as in Canada (British Columbia) and South America.

HOSTS

The larvae and nymphs are found in the ears of many large mammals, particularly cattle, horses, sheep, deer, goats, and dogs. There are a few reports of human infestations.

LOCATION ON HOST

The larvae and nymphs are found deep in the ears of the host. Adults do not have functional mouthparts, do not feed, and are not found on animals. Careful inspection of the ears is essential to locate this species. The use of a curette is needed to establish definitely that ticks are not present.

SEASONAL ACTIVITY

Immature stages may be found on animals throughout the year, but the injurious effects are usually most pronounced in the winter and spring.

LIFE CYCLE SUMMARY

The following information is chiefly adapted from Hooker, Bishopp, and Wood:

This is an aberrant 1-host tick. Only the larval and nymphal stages feed; the adult stage completes the life cycle on food obtained during the second nymphal stage. The last molt, which produces the adults, occurs in the environment away from the host.

Female lays.....as many as 1,500 eggs
Preoviposition period.....usually 8–12 days
Oviposition period..approximately 14–180 days
Incubation of the eggs.....10–23 days
Larvae engorge and molt.....7–12 days
Nymphs [17] engorge and molt.....31–209 days
Adults do not feed
Unfed larvae survive...approximately 80 days
Unmated females survive.....up to 638 days

Loomis reports that the life cycle may be completed (in the laboratory) in 62–118 days. Therefore, under favorable conditions, the completion of several life cycles is possible each year.

ECONOMIC IMPORTANCE

In arid and semiarid areas of the Southwestern and Western States this species is a serious pest of cattle and horses. By attaching deep in the ears, it causes considerable irritation and pain. Animals become restless, shake and rub their heads, and run about until they become exhausted. Dairy animals produce less milk and beef cattle often show significant loss of weight.

The injury produced by the spinose ear tick predisposes the host to attack by screwworms *(Cochliomyia hominivorax)* and secondary bacterial invaders of the inner ear; death often follows.

Otobius megnini has been found naturally infected with *Coxiella burneti* and may be an important focus of infection for livestock.

Rhipicephalus appendiculatus Neumann, the Brown ear tick

DISTRIBUTION

The brown ear tick is widely distributed in parts of southern, central, and eastern Africa. It occurs in the wetter areas and is absent in deserts and in areas without shrub cover.

HOSTS

This is primarily a cattle tick and all parasitic stages thrive on cattle. Secondary hosts include sheep, goats, dogs, buffalo, antelopes, and other mammals. The immatures are reported from hares and other smaller mammals, but prefer the same larger hosts as the adult ticks.

LOCATION ON HOST

The following statement is from Yeoman and Walker:

"By far the most important predilection site for *R. appendiculatus* is the inside of the flap of the ear, in particular the proximal third of the upper edge, where the fringe of long hairs grows. Owing to the curvature of the ear, quite large numbers of ticks can be attached on this

[17] The spinose ear tick has two nymphal stages.

site without being visible to anyone merely looking at the standing animal. We have known field staff and cattle owners to deny the presence of any ear ticks but when the animals were properly restrained and the ears were opened ticks were found to be numerous."

This direct quotation is used because it clearly points out the necessity and importance of carefully examining the ears of imported livestock and exotic animals.

In heavy infestations ticks may be found on the head, neck, abdomen, genitalia, and extremities.

SEASONAL ACTIVITY

In South Africa, the adults are reported to be most abundant on hosts from November to March; the immatures are absent on hosts during this period. The larvae are usually most abundant on hosts during May through July and decline in August. The nymphs occur on hosts from June through September and decline in October.

LIFE CYCLE SUMMARY

The following information is adapted from Theiler; and du Toit and Theiler:

Rhipicephalus appendiculatus is a 3–host tick.

The female lays	up to 5,700 eggs
Preoviposition	5–40 days
Oviposition to hatching	28 days–3 months
Larva feeds	3–7 days
Premolting period	10–49 days
Nymph feeds	3–7 days
Premolting period	10–61 days
Female feeds	4–10 days
Unfed larvae survive	up to 10 months
Unfed nymphs survive	up to 15 months
Unfed adults survive	up to 2 years

In areas where there is a single rainy season each year, the brown ear tick completes one life cycle a year. However, in areas with two rainy seasons each year, as many as three generations may occur within a 1–year period.

ECONOMIC IMPORTANCE

The brown ear tick is the most important tick involved in the transmission of East Coast fever *(Theileria parva)* of cattle in eastern, central, and southern Africa. *Theileria parva* is not transovarially transmitted as is *Babesia bigemina* by *Boophilus microplus;* instead, only trans-stadial (stage-to-stage) transmission occurs. For instance, infection is either picked up by the larva and transmitted to a susceptible host by the nymph, or it is picked up by the nymph and transmitted by the adult. Infection is not carried through the egg to the larva of the next generation.

Other protozoal diseases of cattle transmitted by *R. appendiculatus* include Corridor disease *(T. lawrencei),* benign bovine theileriosis *(T. mutans),* and bovine piroplasmosis *(Babesia bigemina).*

Three viral diseases of sheep are transmitted by this tick: louping ill (experimentally), Nairobi sheep disease, and Kisenyi sheep disease.

In South Africa, *R. appendiculatus* has been associated with the development of tick toxicosis in cattle following very heavy tick infestations.

The wounds produced by the feeding of the brown ear tick can become infected and develop abscesses which often result in severe injury or even loss of the ears.

Rhipicephalus evertsi evertsi Neumann, the Red–legged tick

DISTRIBUTION

The red-legged tick is widely distributed in parts of eastern, western, central, and southern Africa as well as in the mountains of Yemen in southwestern Arabia.[18]

In September 1960, *R. e. evertsi* was found on a variety of wild animals confined in two zoological compounds in Florida and on a wild game farm in New York. Following a concerted eradication effort, the red-legged tick was declared eradicated from the United States in January 1962. This tick is frequently found on zebras, antelopes, and other wild animals from Africa which are being held in quarantine prior to release for entry into the United States.

[18] In the very dry regions of southwest Africa, the subspecies *Rhipicephalus evertsi mimeticus* Donitz replaces *R. e. evertsi.* Both subspecies occur together in the savannahs of western equatorial Africa.

HOSTS

The adults commonly occur on domesticated equines, cattle, goats, and sheep and on wild antelopes, zebras, and several other large game animals. Immature stages usually feed on the same hosts as the adult ticks, but have been known to occur on smaller mammals such as hares, elephant shrews, tree rats, and grass mice.

LOCATION ON HOST

Adults prefer to attach in the peri-anal area, under the base of the tail, and less frequently on the teats, groins, and scrotum. Immatures are found *deep* in the convolutions of the external ear. A curette should be used in examining the ears for the immature stages.

SEASONAL ACTIVITY

This tick can occur on hosts throughout the year but is more active in the summer than in the winter.

LIFE CYCLE SUMMARY

The following information is adapted from Theiler; and du Toit and Theiler:

Rhipicephalus e. evertsi is a 2–host tick.

Female lays	5,000–7,000 eggs
Preoviposition period	6–24 days
Eggs hatch	4–10 weeks
Larvae and nymphs on host	10–15 days
Nymphs molt	42–56 days
Females engorge	6–10 days
Total	92–175 days
Unfed larvae survive	up to 7 months
Unfed adults survive	up to 14 months

ECONOMIC IMPORTANCE

Rhipicephalus e. evertsi is a very important tick in the areas of eastern, western, central, and southern Africa where it is established. It is known to transmit the following diseases: bovine piroplasmosis *(Babesia bigemina)*, equine piroplasmosis *(B. equi)*, East Coast fever *(Theileri parva)*, benign bovine theileriosis *(T. mutans)*, ovine theileriosis *(T. ovis)*, benign ovine ehrlichiosis *(Ehrlichia ovina)*, and spirochetosis *(Borrelia theileri)* of cattle, sheep, goats, and horses. The red-legged tick has been incriminated in the production of tick paralysis in sheep. Heavy infestations cause "tick worry."

Rhipicephalus pulchellus Gerstacker, the Zebra tick

DISTRIBUTION

This is an east African tick and is primarily found from northern Tanganyika through eastern Kenya into Ethiopia, and Somalia.

Rhipicephalus pulchellus is occasionally found on zebras and other African animals which are being held in quarantine at the U.S. Department of Agriculture quarantine facility for the Port of New York at Clifton, N.J.

HOSTS

This tick is especially fond of zebras, but likes the rhinoceros and a variety of other large herbivores. It feeds on common domesticated animals and readily attacks man. The larvae and nymphs apparently feed on the same hosts as the adults.

LOCATION ON HOST

The zebra tick is usually found on the dewlap, brisket, abdomen, axillae, groins, peri-anal area, and in the tail switch.

SEASONAL ACTIVITY

In enzootic areas this species may be found on the host throughout the year.

LIFE CYCLE SUMMARY

The following information is adapted from Walker.

Rhipicephalus pulchellus is a 3–host tick.

Preoviposition period	6 days
Larvae hatch	39 days
Larvae harden	[19]
Larvae engorge	3 days
Larvae molt	11 days
Nymphs harden	[19]
Nymphs engorge	3 days
Nymphs molt	15 days
Adult harden	[19]
Adults engorge	11 days

[19] Accurate records of time required by each stage for hardening were not kept, but this period is frequently accepted to be approximately 1 week.

ECONOMIC IMPORTANCE

The zebra tick is a vector of the virus of Nairobi sheep disease.

Since *Babesia equi* is a very common parasite in the wild zebra of eastern Africa, this tick should remain in a suspect category as a potential vector of this protozoal disease-producing agent of equines.

Rhipicephalus sanguineus (Latreille), the Brown Dog tick

DISTRIBUTION

Rhipicephalus sanguineus is one of the most widely distributed tick species in the world. It is believed to be a native of Africa, but has been distributed throughout the tropical and warm-temperate parts of the world with the migration of man and his dogs. The brown dog tick is established in North, Central, and South America, the West Indies, Africa, Madagascar, the Middle East, East Indies, China, Australia, Micronesia, southern Europe, and other areas.

HOSTS

In the United States, the brown dog tick almost exclusively attacks dogs; when it is found on other hosts such as horses, cattle or man, there is usually a history of close association with dogs.

In other areas of the world, *R. sanguineus* has been reported from a wide variety of medium- and large-size mammals and ground-feeding birds. Some of these hosts include buffalo, camel, cat, cattle, deer, goat, horse, sheep, lion, zebra, ground-feeding birds (ostrich, bustard, ibis, hornbill, buzzard), hare, hedgehog, reptiles, and man. This unusually wide host range leads one to suspect that *R. sanguineus* has either developed physiological races with adaptation to particular hosts, or it consists of a complex of distinct species which are morphologically, if not physiologically, similar to the classical brown dog tick. In Africa, the immature stages of *R. sanguineus* occur on a wide range of small mammals.

LOCATION ON HOST

On the dog, the adult stage is commonly found in the ears, along the nape of the neck, and between the toes. The immatures often attach in the long hair on the neck. In heavy infestations, all active stages may be found attached to the hairy parts of the body.

SEASONAL ACTIVITY

This tick is found on hosts throughout the year in tropical or subtropical areas. In warm-temperate areas, where definite seasonal changes occur, ticks are commonly found on hosts from early spring until fall. Few ticks are found on animals during the winter. The brown dog tick is unable to survive outdoors in the Northern States, but when provided protection in heated houses and kennels, it is commonly found as far north as Connecticut.

LIFE CYCLE SUMMARY

The following information is adapted from Hooker, Bishopp, and Wood; and Nuttall in Hoogstraal.

Rhipicehalus sanguineus is a 3–host tick.

The female lays	approximately 4,000 eggs
Preoviposition period	3–83 days
Incubation of the eggs	8–67 days
Larvae engorge	3–7 days
Larvae molt	6–23 days
Nymphs engorge	4–9 days
Nymphs molt	12–129 days
Females engorge	6–50 days
Unfed larvae survive	up to 253 days
Unfed nymphs survive	up to 183 days
Unfed adults survive	up to 568 days

Under favorable conditions, the life cycle may be completed in 63 days; in warm areas, several generations may be expected each year.

ECONOMIC IMPORTANCE

The brown dog tick is an exceedingly troublesome pest of dogs, causing discomfort, blood loss, and disease. In the United States, it is a vector of *Ehrlichia canis (=Rickettsia canis)*, which causes canine ehrlichiosis, and *Babesia canis*, which causes canine piroplasmosis.

The *Rhipicephalus sanguineus* complex is a very efficient vector of many disease-producing agents. In other areas of the world, it is incriminated in the natural or experimental transmission of many diseases of man and animals, including boutonneuse fever *(Rickettsia conori)*, Rocky Mountain spotted fever *(R.*

rickettsi), spirochetosis *(Borrelia theileri)* tularemia *(Francisella tularensis)*, equine piroplasmosis *(Babesia caballi* and *B. equi)*, anaplasmosis *(Anaplasma marginale)*, Q fever *(Coxiella burneti)*, and other diseases. See Hoogstraal (1956) and Neitz.

The disease relationships should not be assumed to apply to *R. sanguineus*, which is now established in the United States. The U.S. "race" of the brown dog tick is not commonly found on hosts, other than dogs, and it is not known to be important in the transmission of diseases other than canine ehrlichiosis and piroplasmosis. The United States form of *R. sanguineus* may or may not be capable of transmitting all the diseases attributed to it throughout the world. Nevertheless, the brown dog tick should remain in a suspect category until the questions regarding classification and disease transmission are resolved.

In the United States, *R. sanguineus* often becomes an annoying pest in households where dogs are kept. All active stages may be found crawling about the walls, curtains, and furniture. The homeowner often becomes greatly alarmed, but fortunately this tick does not readily feed on man and is not known to naturally transmit any disease of man in the United States. Elimination of brown dog ticks from premises is difficult because of the hardiness and longevity of all active stages, the ready availability of the canine host, and the development of acaricidal-resistant strains in some areas.

XV. CHECKLIST OF THE TICKS OF THE UNITED STATES

Scientific Name	Principal Host(s)
Family Argasidae	
Genus *Argas* Latreille:	
brevipes Banks	Owls, sparrow hawk, woodpecker
cooleyi Kohls and Hoogstraal	Cliff swallow
giganteus Kohls and Clifford	Several wild birds
miniatus Koch	Chicken
persicus (Oken)	Chicken
radiatus Railliet	Chicken, wild turkey, vulture
sanchezi Dugès	Chicken, dove, quail, turkey
Genus *Antricola* Cooley and Kohls:	
coprophilus (McIntosh)	Bats
Genus *Ornithodoros* Koch:	
capensis Neumann	Marine birds
concanensis Cooley and Kohls	Probably bats
cooleyi McIvor	Small mammals
coriaceus Koch	Deer, cattle, man
denmarki Kohls, Sonenshine and Clifford	Marine birds
dyeri Cooley and Kohls	Bats
eremicus Cooley and Kohls	Mice
hermsi Wheeler, Herms, and Meyer	Chipmunks, deer mice, wood rats
Ornithodoros kelleyi Cooley and Kohls:	Bats
parkeri Cooley	Various small mammals, burrowing owl
sparnus Kohls and Clifford	Wood rats
stageri Cooley and Kohls	Bats

XV. CHECKLIST OF THE TICKS OF THE UNITED STATES—Con.

Scientific Name—Con.	Principal Hosts(s)—Con.
Family Argasidae—Con.	
talaje (Guérin-Méneville)	Wild rodents
turicata (Dugès)	Various rodents, pigs, burrowing owls
yumatensis Cooley and Kohls	Bats
Genus *Otobius* Banks:	
lagophilus Cooley and Kohls	Rabbits
megnini (Dugès)	Livestock
Family Ixodidae	
Genus *Amblyomma* Koch:	
americanum (Linnaeus)	Livestock, deer, birds, man
cajennense (Fabricius)	Livestock, man
dissimile Koch	Snakes, Iguana
imitator Kohls	Variety of domestic and wild animals
inornatum (Banks)	Small mammals, cattle, deer
maculatum Koch	Variety of mammals and birds
tuberculatum Marx	Gopher–tortoise
Genus *Aponomma* Neumann	
elaphensis Price	Snake
Genus *Boophilus* Curtice	
annulatus[20] (Say)	Cattle
microplus[20] (Canestrini)	Cattle
Genus *Dermacentor*	
albipictus (Packard)	Cattle, horses, deer
andersoni Stiles, syn. *D. venustus* Banks	Variety of mammals
halli McIntosh	Peccary (Javelina)
hunteri Bishopp	Bighorn sheep
nigrolineatus (Packard)	Cattle, horses, deer
nitens Neumann, syn. *Anocentor nitens* (Neumann)	Horses
occidentalis Marx	Variety of mammals
parumapertus Neumann	Rabbits
variabilis (Say)	Variety of mammals

[20] Not presently established; occasionally introduced into Texas from Mexico.

XV. CHECKLIST OF THE TICKS OF THE UNITED STATES—Con.

Scientific Name—Con.	Principal Hosts(s)—Con.
Family Ixodidae—Con.	
Genus *Haemaphysalis* Koch	
chordeilis (Packard)	Birds
leporispalustris (Packard)	Rabbits
Genus *Ixodes* Latreille	
affinis Neumann	Deer, small mammals
angustus Neumann:	Variety of small mammals
auritulus Neumann	Birds
baergi Cooley and Kohls	Cliff swallows
banksi Bishopp	Small mammals
brunneus Koch	Birds
californicus Banks	Birds
conepati Cooley and Kohls	Hog-nosed skunk
cookei Packard	Small mammals
dentatus Marx	Cottontail rabbit
diversifossus Neumann	Raccoon
eadsi Kohls and Clifford	Small rodents
hearlei Gregson	Red squirrel
holdenreidi Cooley	Pocket gopher
howelli Cooley and Kohls	Birds
jellisoni Cooley and Kohls	Mice
kingi Bishopp	Small mammals
marmotae Cooley and Kohls	Woodchucks
marxi Banks	Squirrels
minor Neumann	Birds
muris Bishopp and Smith	Small rodents
neotomae Cooley	Small mammals
ochotonae Gregson	Pika
pacificus Cooley and Kohls	Variety of mammals
peromysci Augustson	Mice
rugosus Bishopp	Skunk, dog
scapularis Say	Variety of mammals and birds
sculptus Neumann	Ground squirrels
signatus Birula	Sea birds
soricis Gregson	Shrews
spinipalpis Hadwen and Nuttall	Small mammals
texanus Banks	Small mammals
tovari Cooley	Hares
uriae White	Marine birds
woodi Bishopp	Wood rat
Rhipicephalus Koch:	
sanguineus (Latreille)	Dogs

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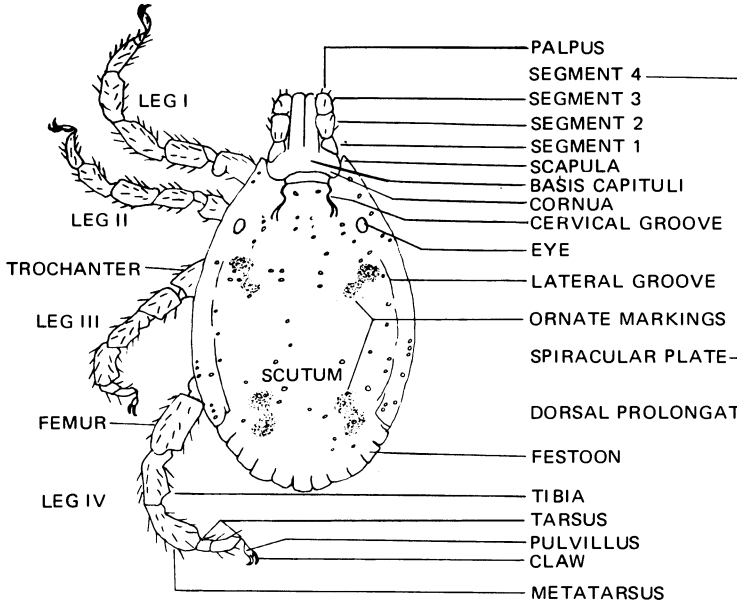
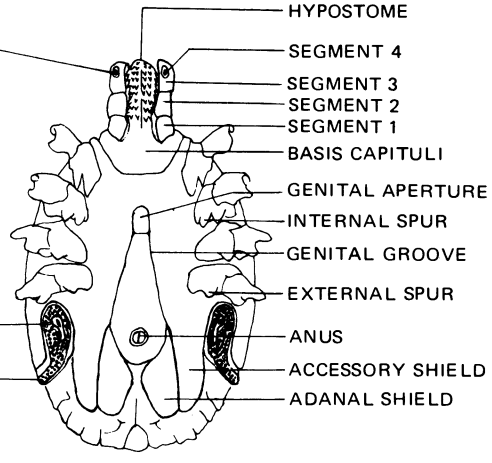
HYPOTHETICAL MALE AND FEMALE HARD TICKS WITH KEY MORPHOLOGICAL CHARACTERS LABELED



DORSUM OF MALE



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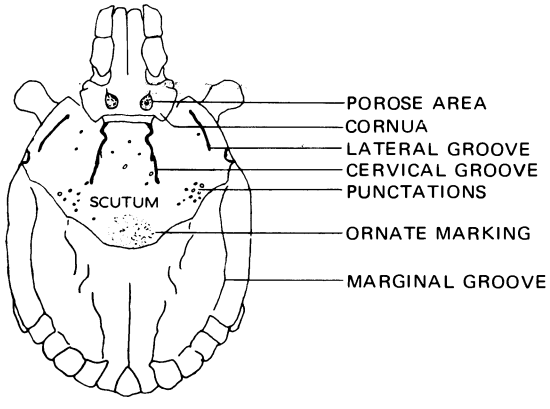

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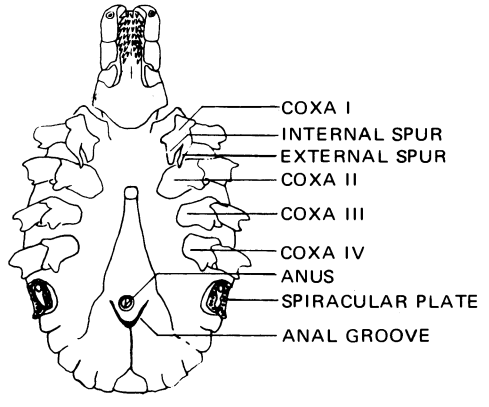

VENTER OF FEMALE

HYPOTHETICAL SOFT TICKS
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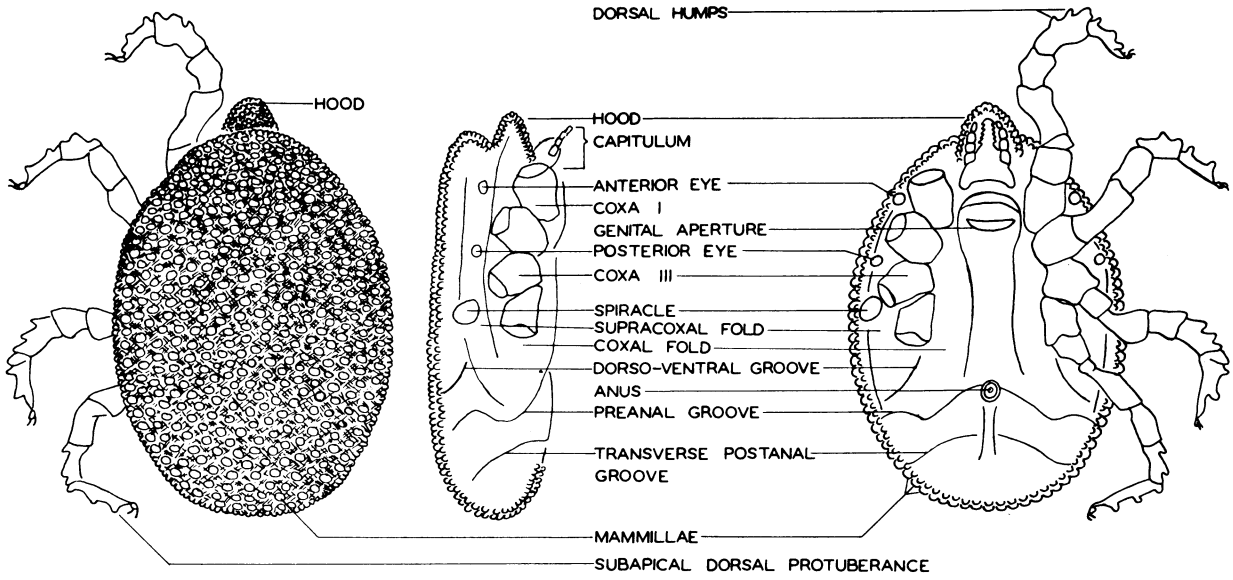
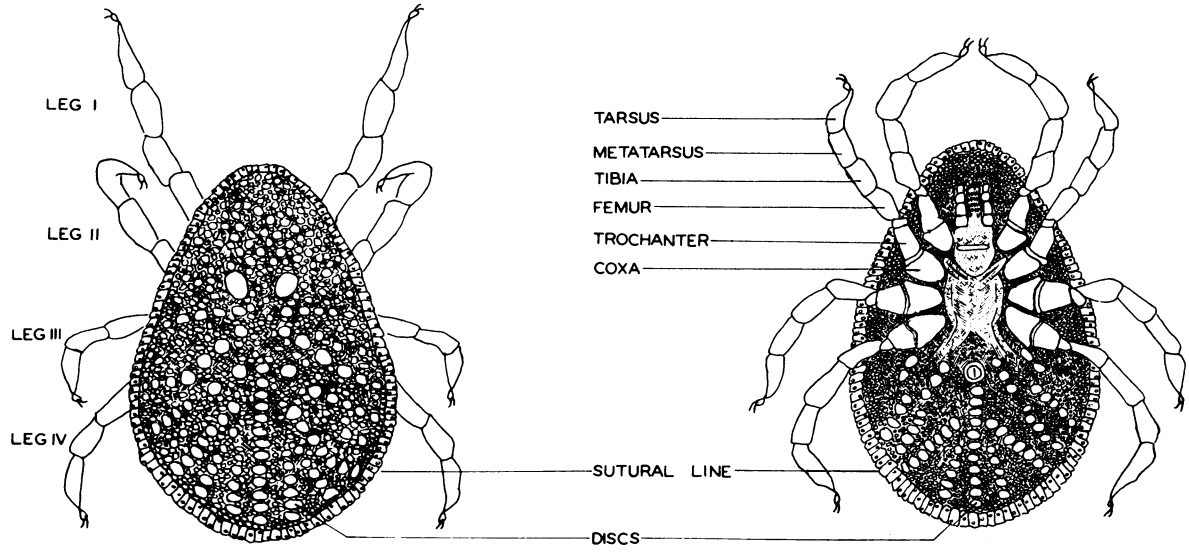


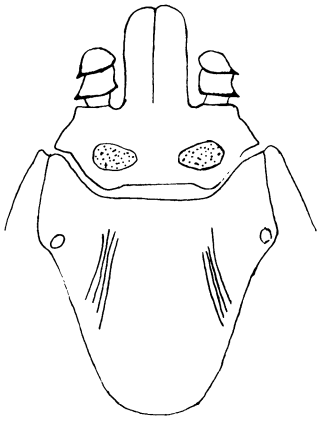
DORSUM VENTER

LATERAL VIEW

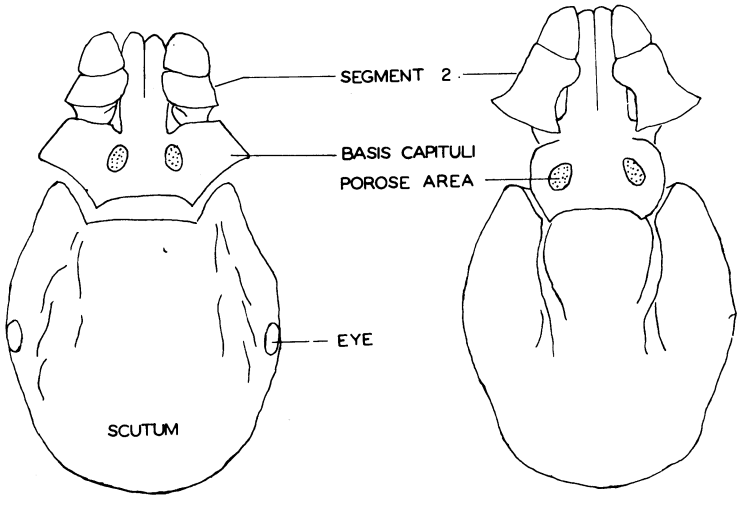


DORSUM VENTER

DORSAL VIEW OF THE SCUTA AND CAPITULA OF SOME FEMALE IXODIDAE (HARD TICKS), SHOWING CHARACTERISTICS OF THE GENERA

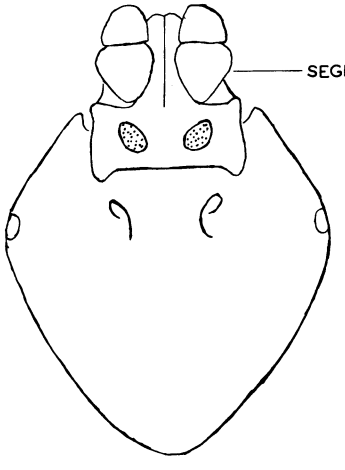


BOOPHILUS

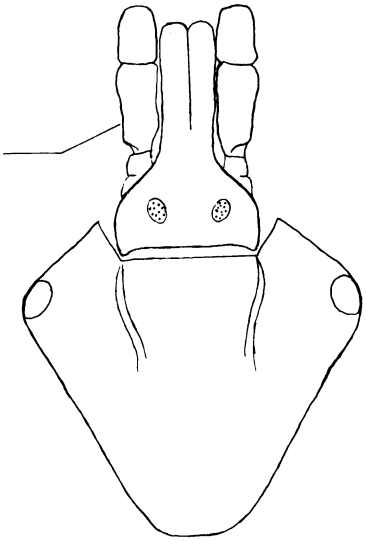


RHIPICEPHALUS

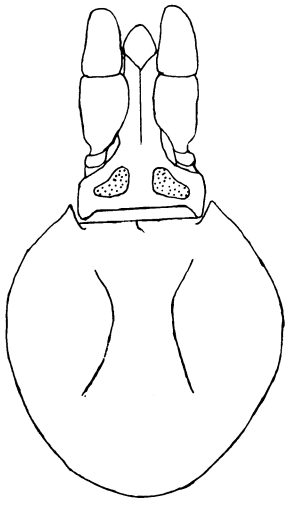
HAEMAPHYSALIS



DERMACENTOR



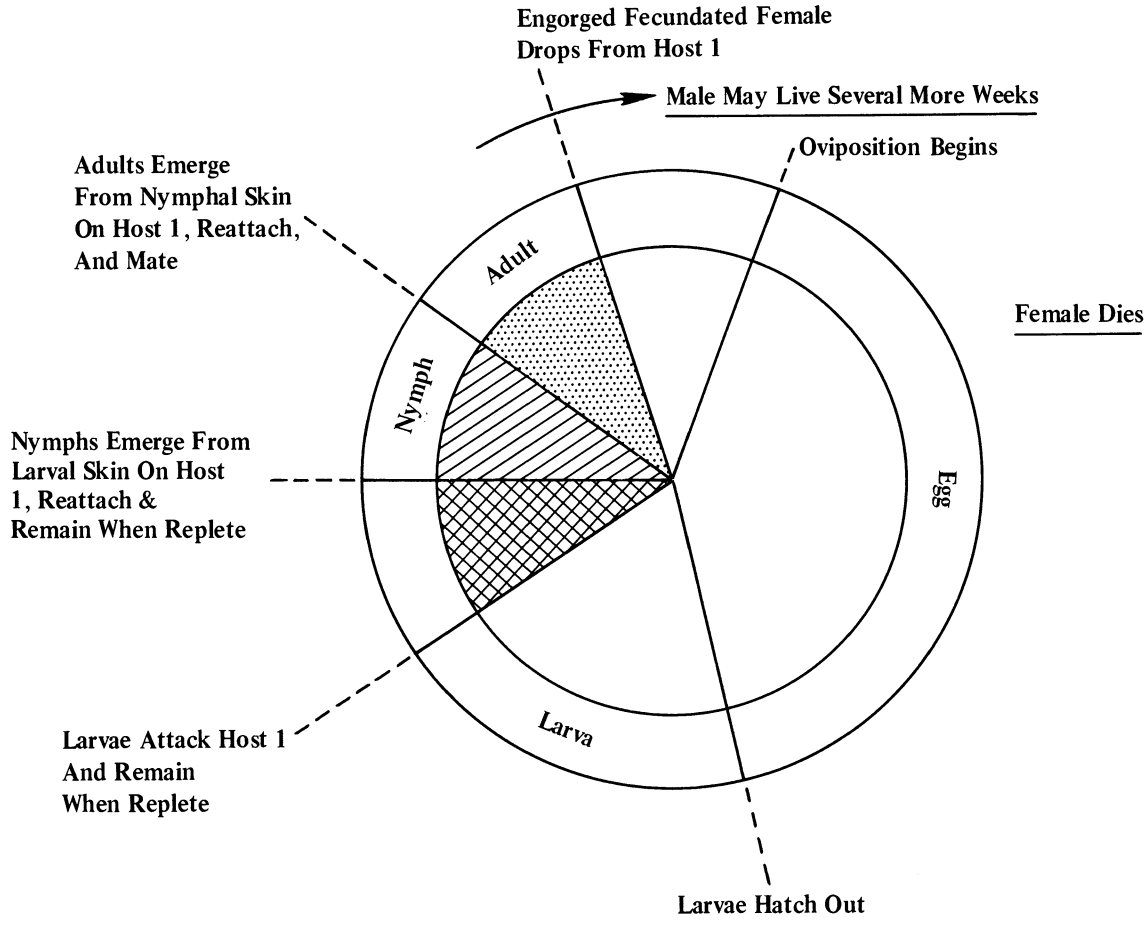
AMBLYOMMA



IXODES

SCHEMATIC LIFE CYCLES AND DISEASE TRANSMISSION OF TICKS

TYPE I

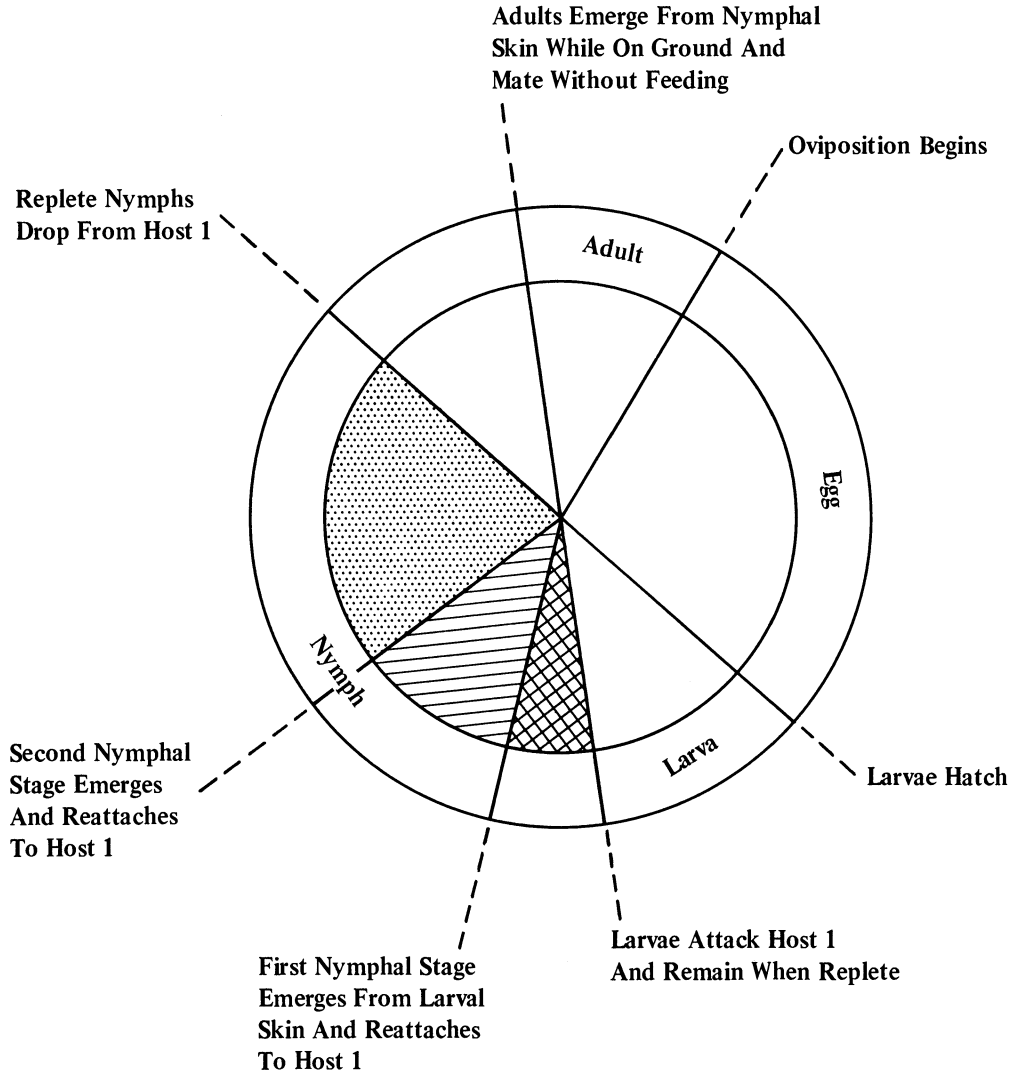


This type has one host and is represented by *Boophilus decoloratus*, and *Dermacentor nitens*. The entire life cycle from larva to adult is spent on the same host. Feeding of the tick is twice interrupted for molting, but the tick remains on the same host. The possibilities for disease transmission are continuous through all the parasitic stages. Disease organisms taken up during the parasitic period either die or may be passed transovarially to be transmitted by the offspring of the tick.

Apparently some disease organisms, especially *Babesia* spp., may remain in the body of ticks for as many as five generations, even when fed on non-infected, non-susceptible hosts.

SCHEMATIC LIFE CYCLES AND DISEASE TRANSMISSION OF TICKS – Con.

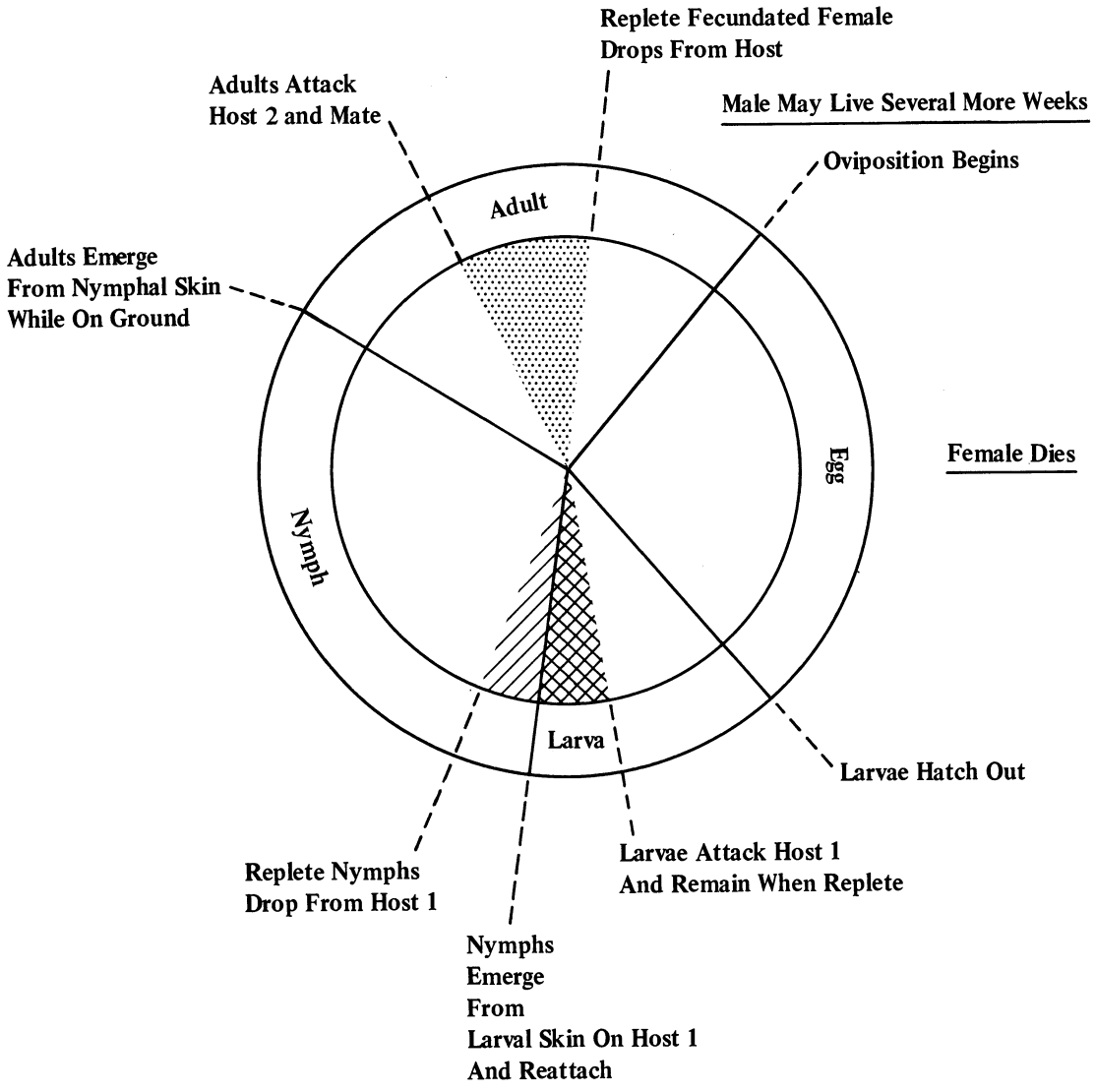
TYPE II



This aberrant type is found in *Otobius megnini*, the spinose ear tick. There is one host on which the larval and two nymphal stages feed. The adult neither attaches nor feeds. Disease organisms taken up by the larva and nymph either die during or after the parasitic period or they may remain in the tick body during transformation, enter the egg and may be transmitted by the offspring.

SCHEMATIC LIFE CYCLES AND DISEASE TRANSMISSION OF TICKS—Con.

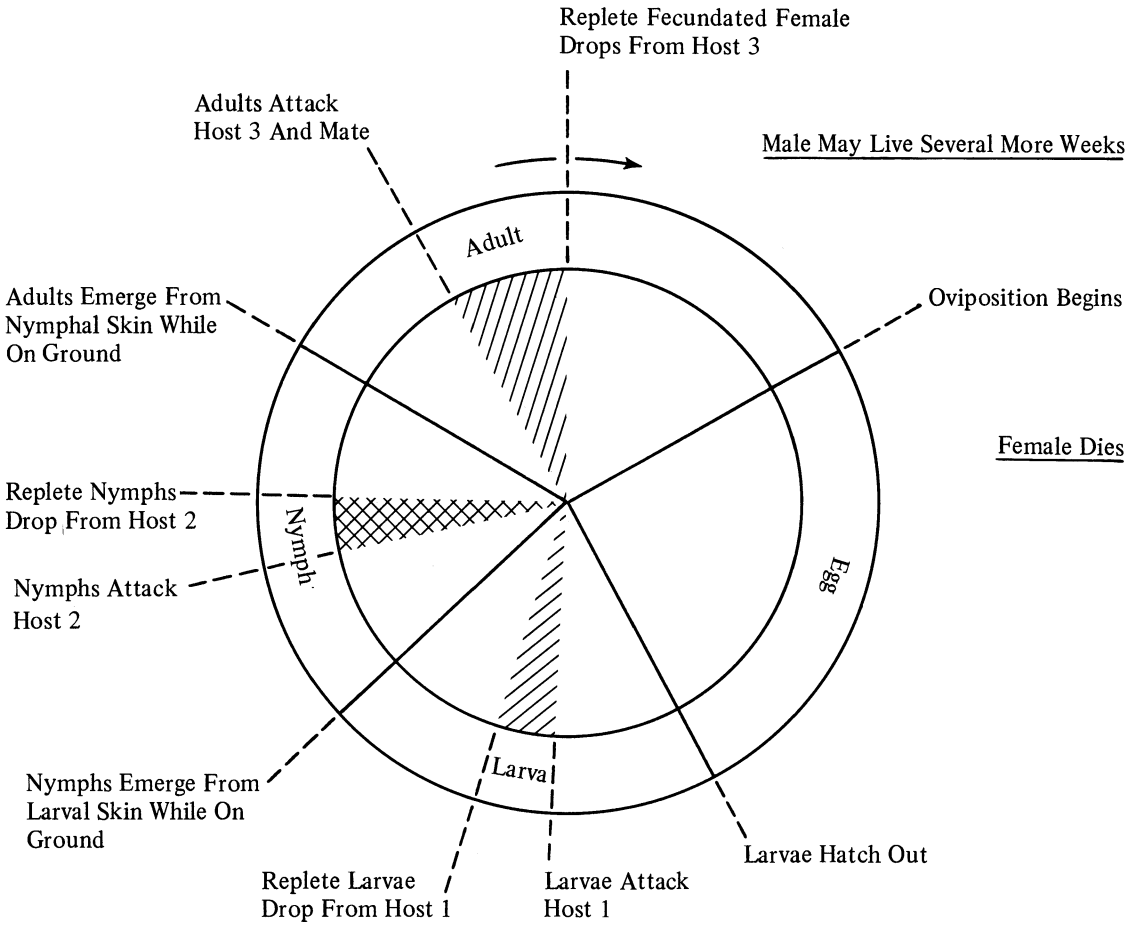
TYPE III



This type, found in *Rhipicephalus evertsi*, has two hosts. The larva and nymph develop on one host. The nymph drops when replete, molts and the adult attaches to the second host. Disease organisms acquired by the immature stages either die or remain in the tick during molting and may be transmitted by the adult to the second host. Disease organisms taken up by the female either die or may be conveyed via the egg and possibly be transmitted by the offspring.

SCHEMATIC LIFE CYCLES AND DISEASE TRANSMISSION OF TICKS—Con.

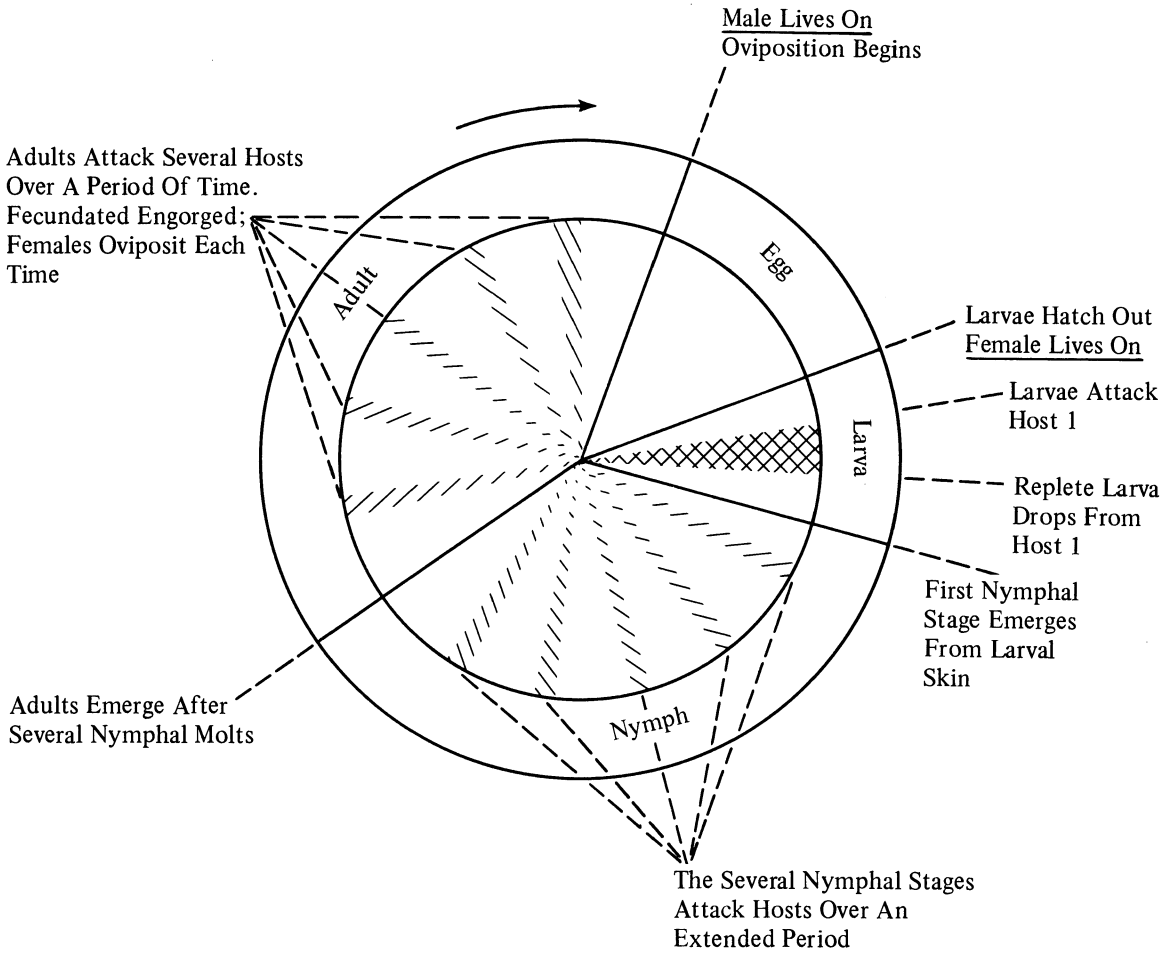
TYPE IV



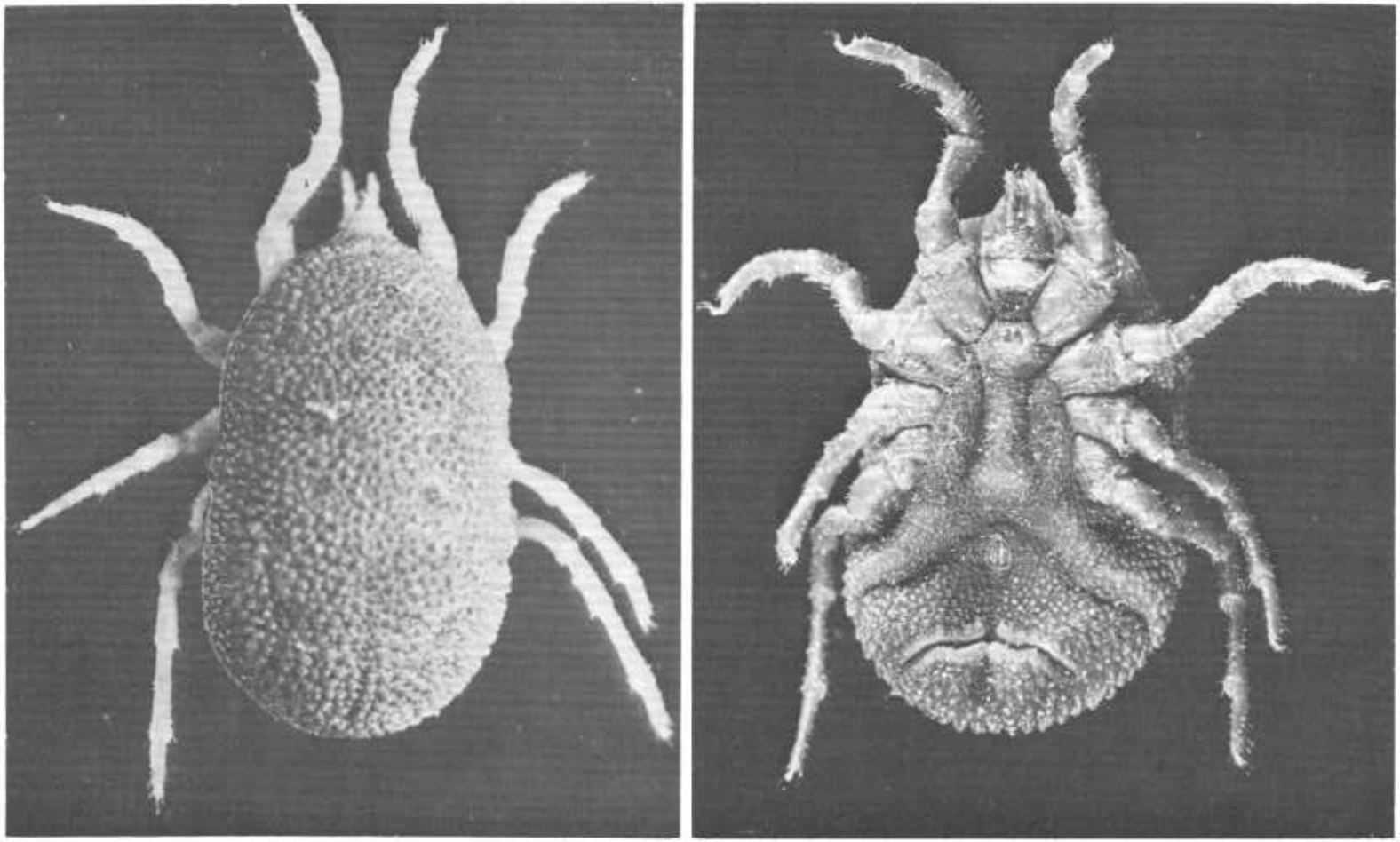
This type, the most common, is found in *Dermacentor variabilis, Amblyomma variegatum*, and most other species of hard ticks. These are the so-called "three-host ticks". The larva attaches, engorges, drops from the host and molts; the nymph reattaches to the same or another host, engorges, drops from the host and molts; and finally, the adult reattaches to the same or another host, engorges, and drops from the host. Therefore, disease organisms taken up by the larva, if able to survive the transformation, may be transmitted to the host of the nymph. Organisms taken up by the nymph which remain in the tick during molting may be transmitted to the host of the adult stage. Disease organisms acquired by the adult either may be passed transovarially to be transmitted by the offspring, or they die within the tick without infecting the next generation.

SCHEMATIC LIFE CYCLES AND DISEASE TRANSMISSION OF TICKS—Con.

TYPE V



This type is found in various species of the soft tick genera *Argas* and *Ornithodoros*. There is one larval host, several nymphal and several adult hosts. Only the larva remains on the host to feed for any length of time. Both the nymph and adult are rapid and repeated feeders. The female usually lays a small batch of eggs after each feeding. If able to survive in the tick, disease organisms taken up by any of the parasitic stages may be transmitted to subsequent hosts or may be passed transovarially to the offspring.

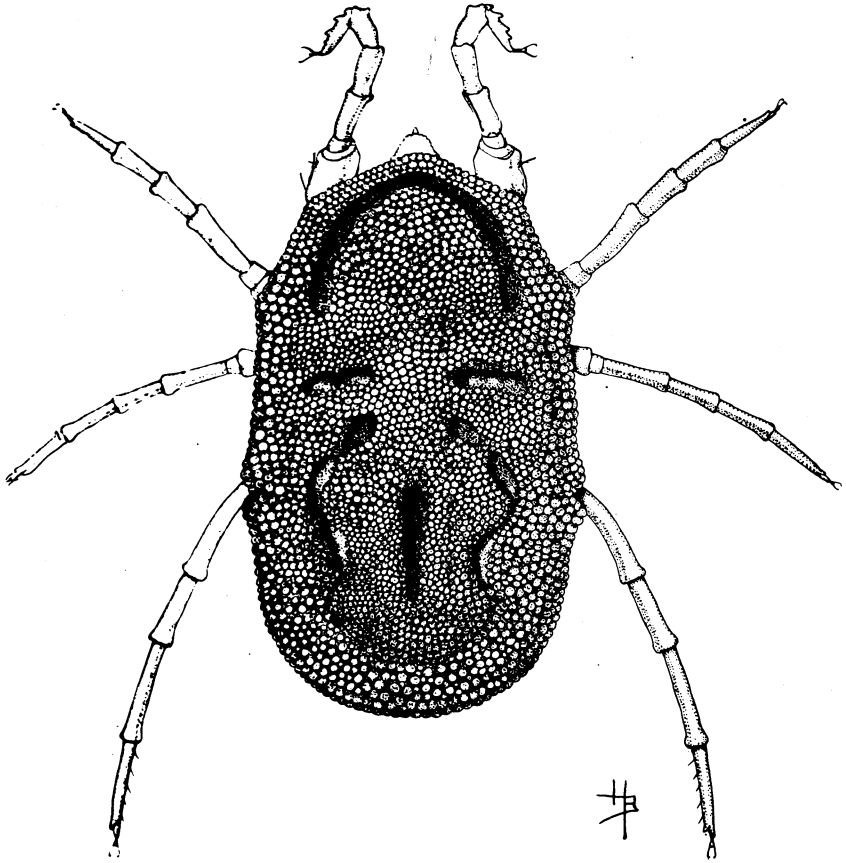


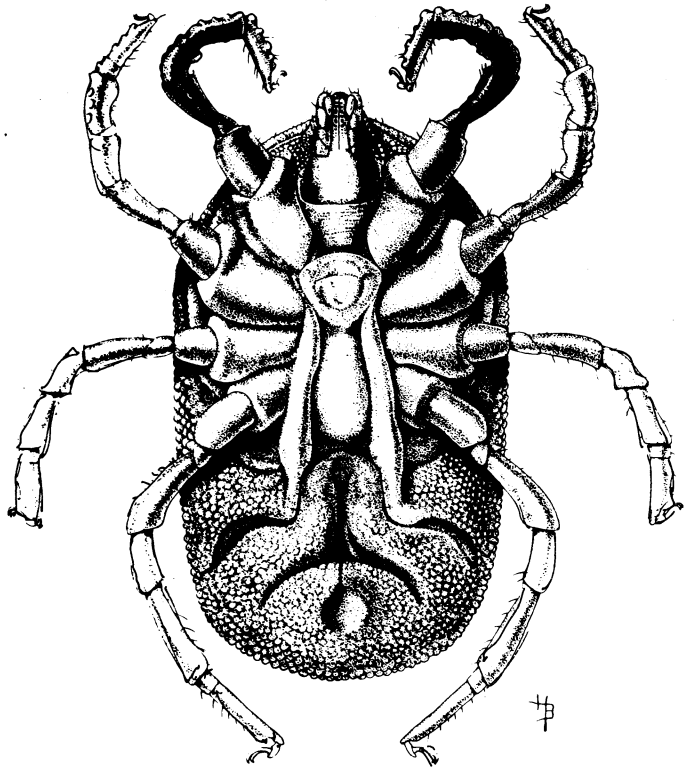
Dorsal

MALE

Ventral

Ornithodoros turicata



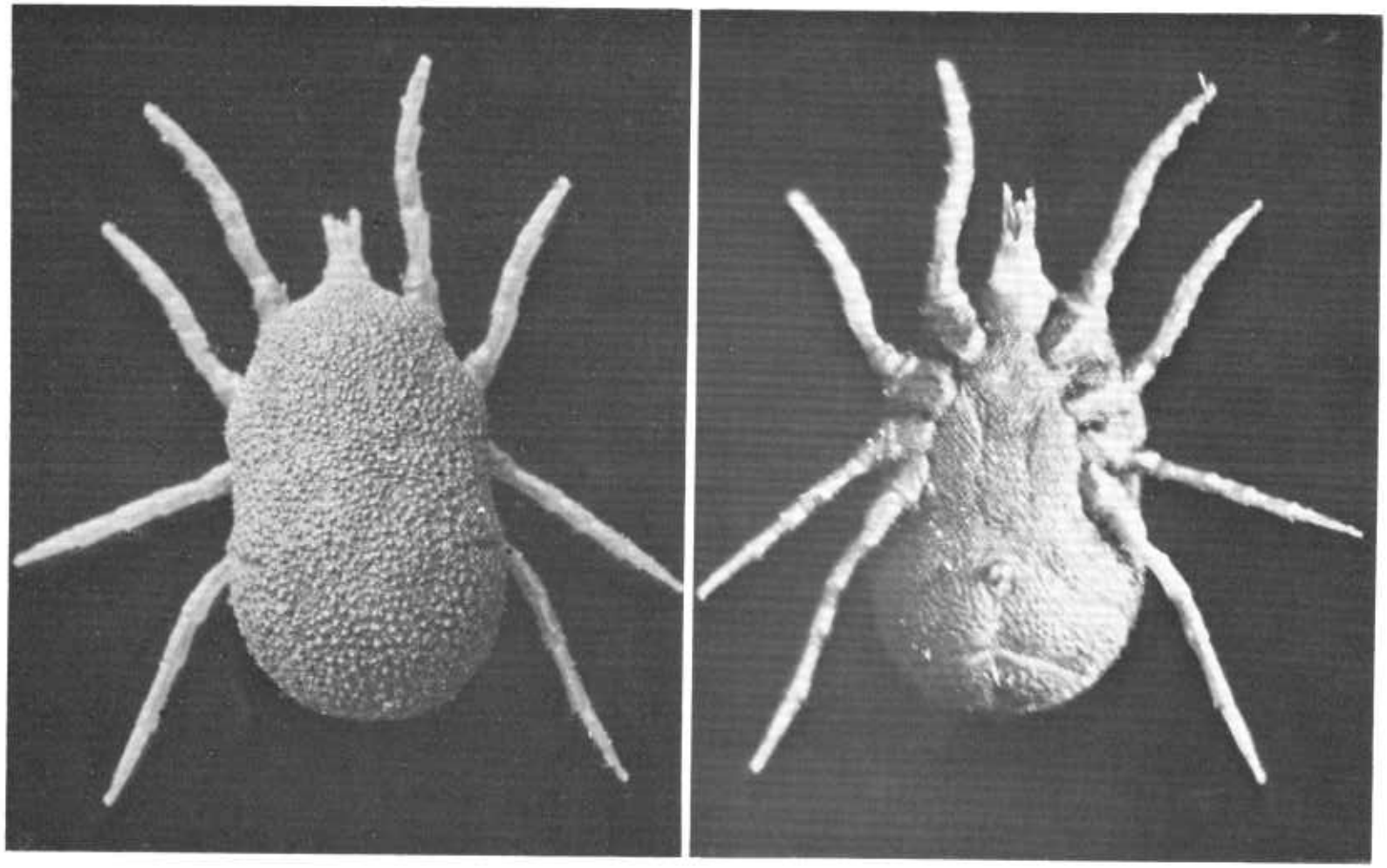


Dorsal

FEMALE

Ventral

Ornithodoros turicata

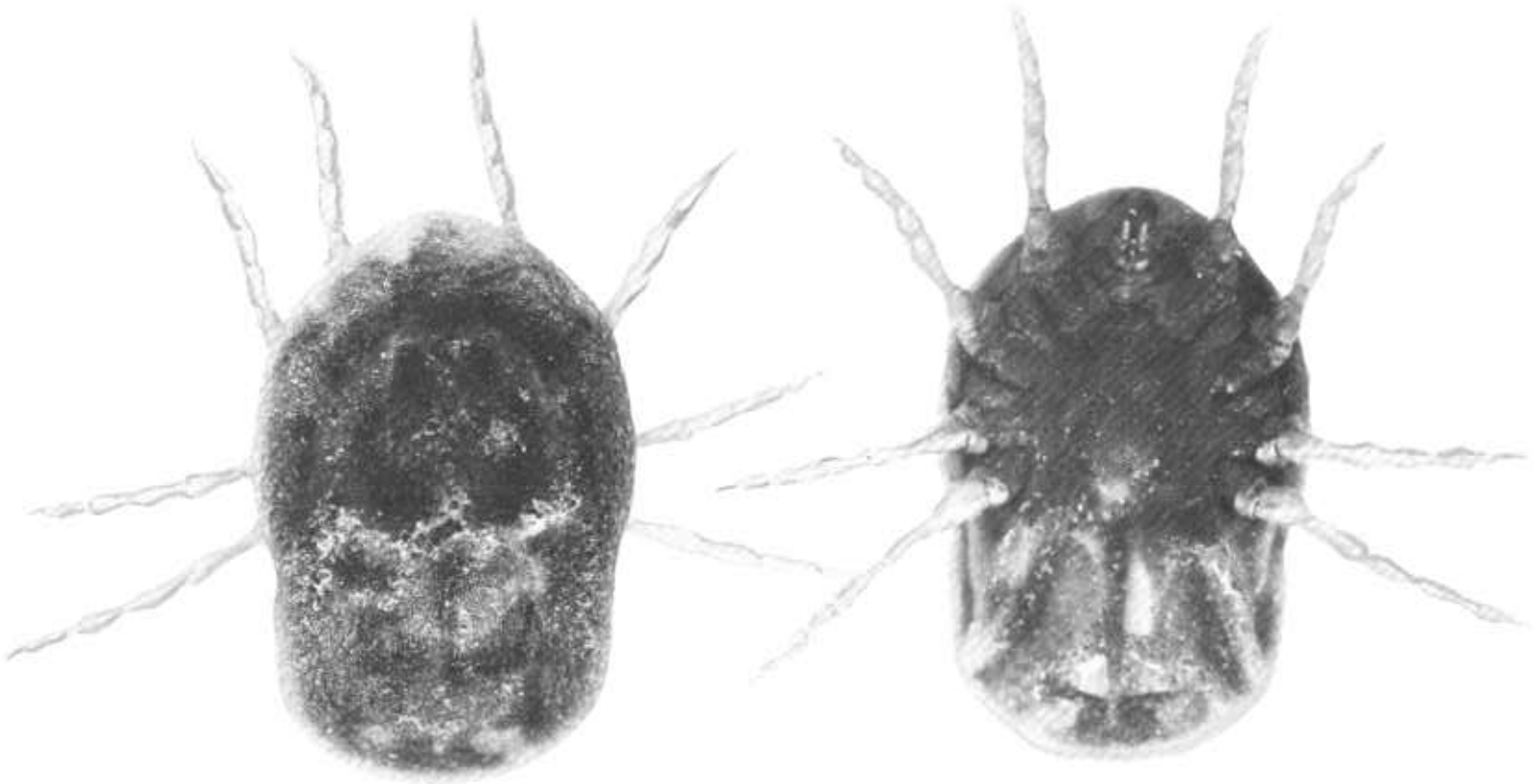


Dorsal

NYMPH

Ventral

Ornithodoros turicata

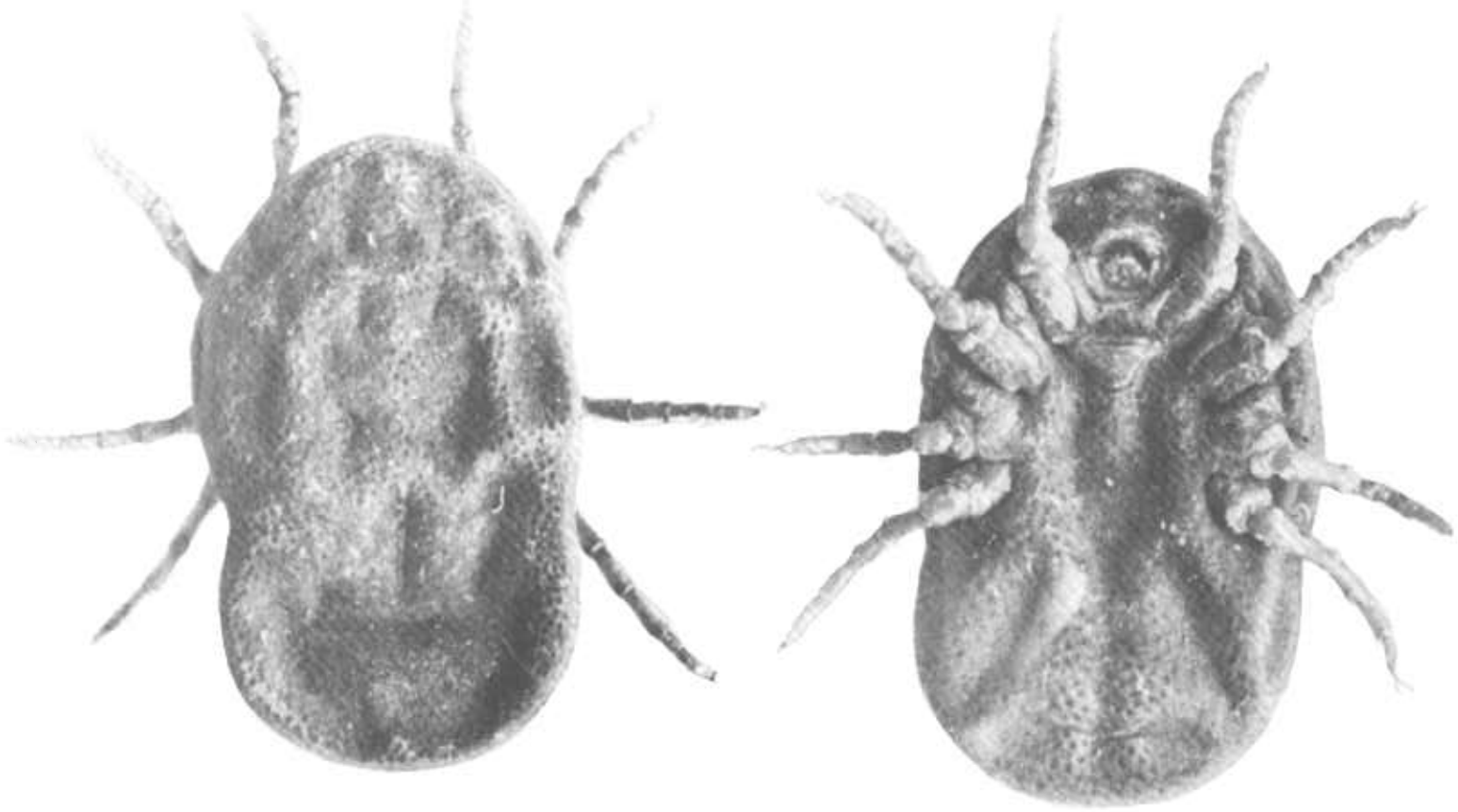


Dorsal

MALE

Ventral

Otobius megnini

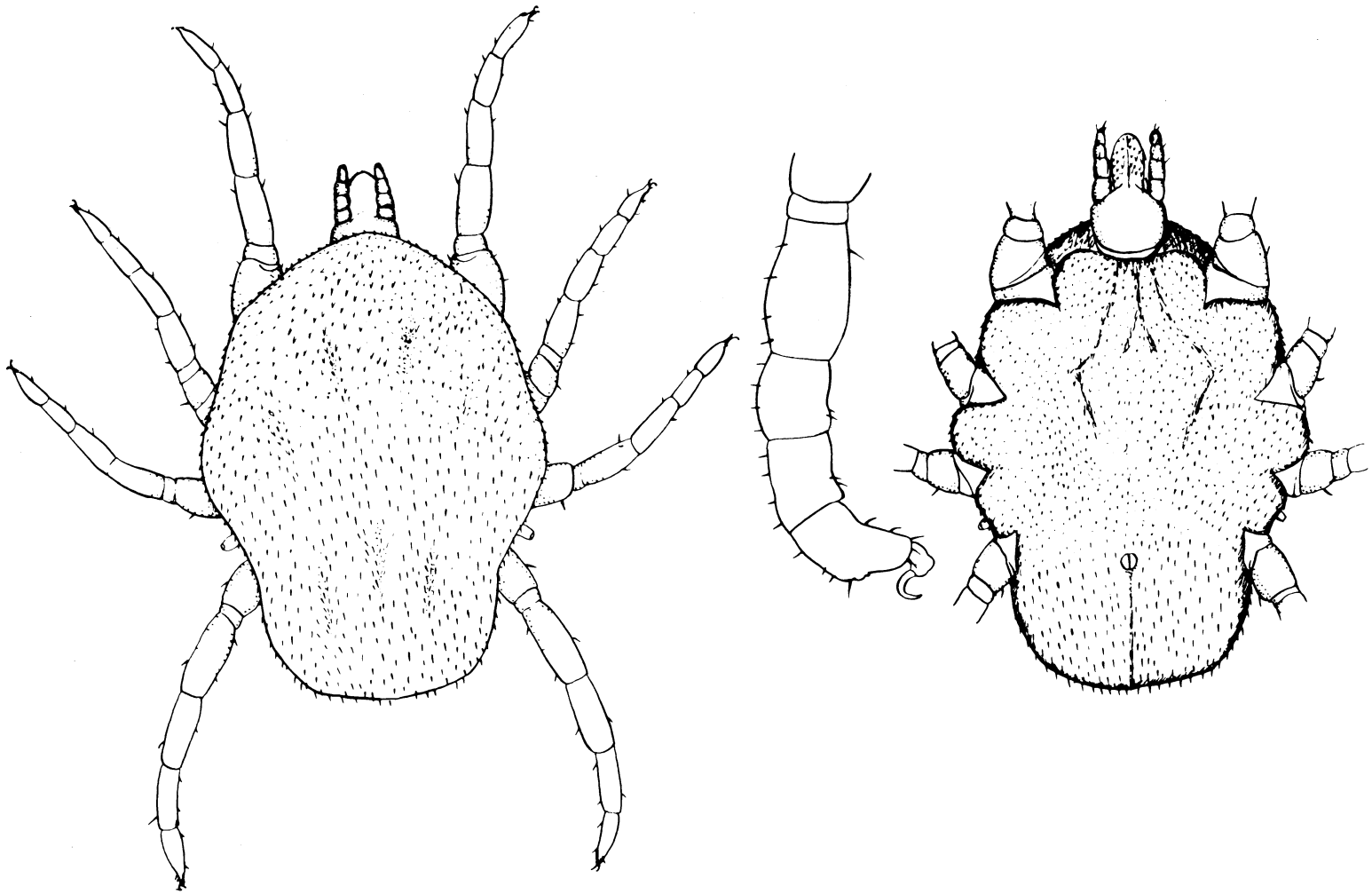


Dorsal

FEMALE

Ventral

Otobius megnini



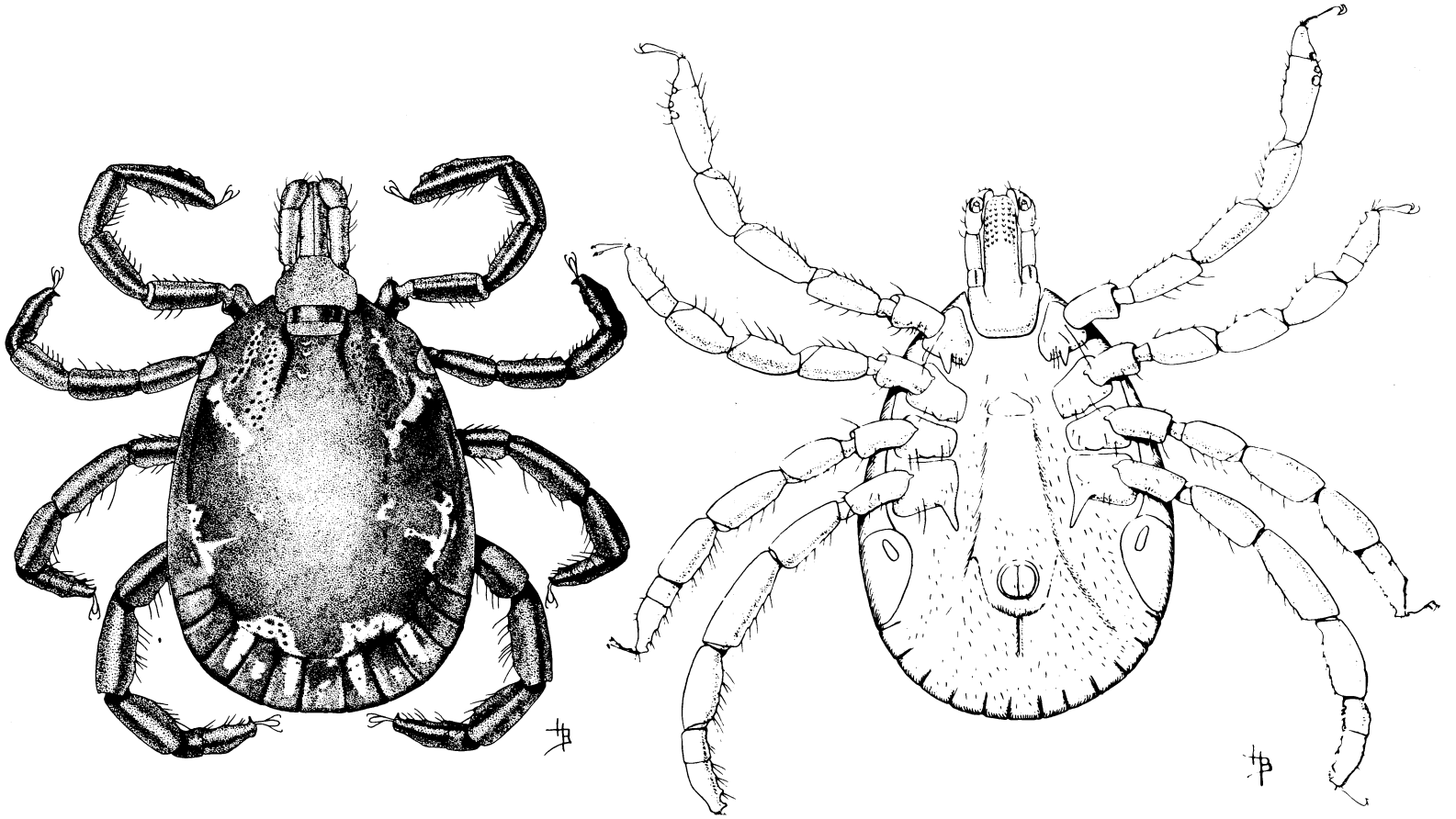
Dorsal

NYMPH

Ventral

Otobius megnini

PLATE 6

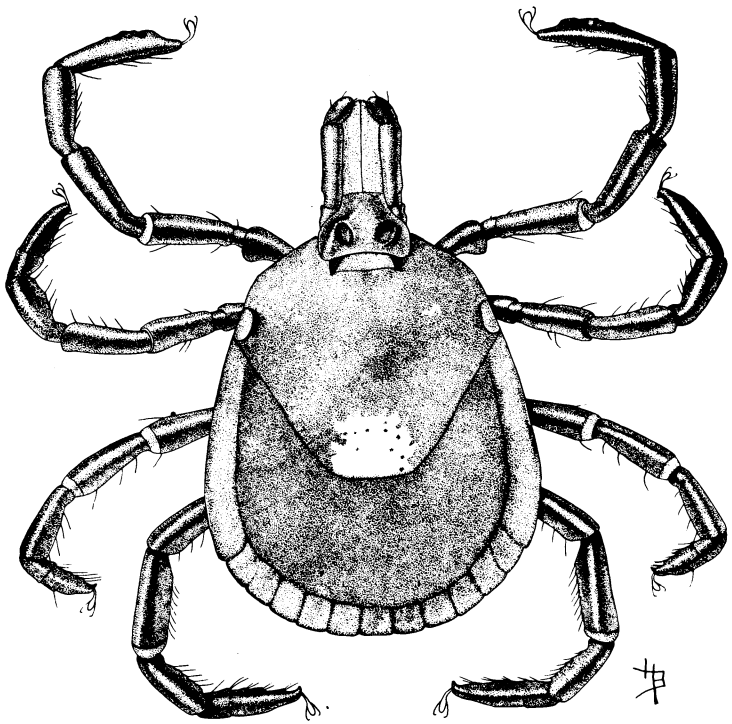


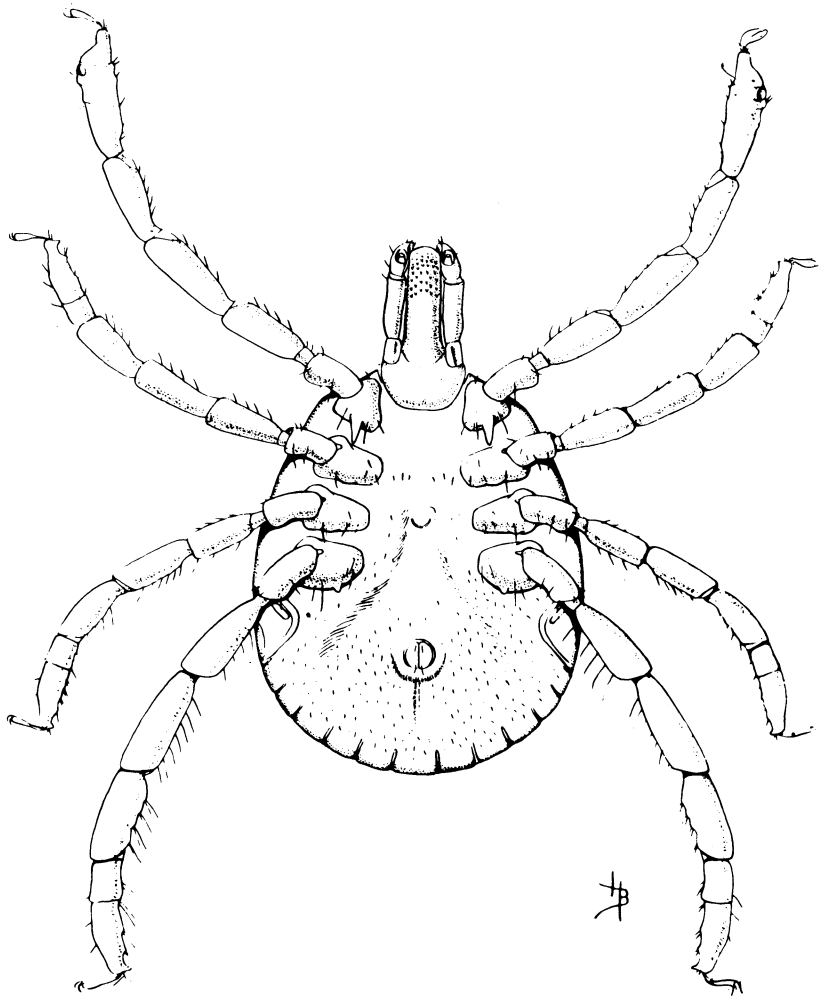
Dorsal

MALE

Ventral

Amblyomma americanum



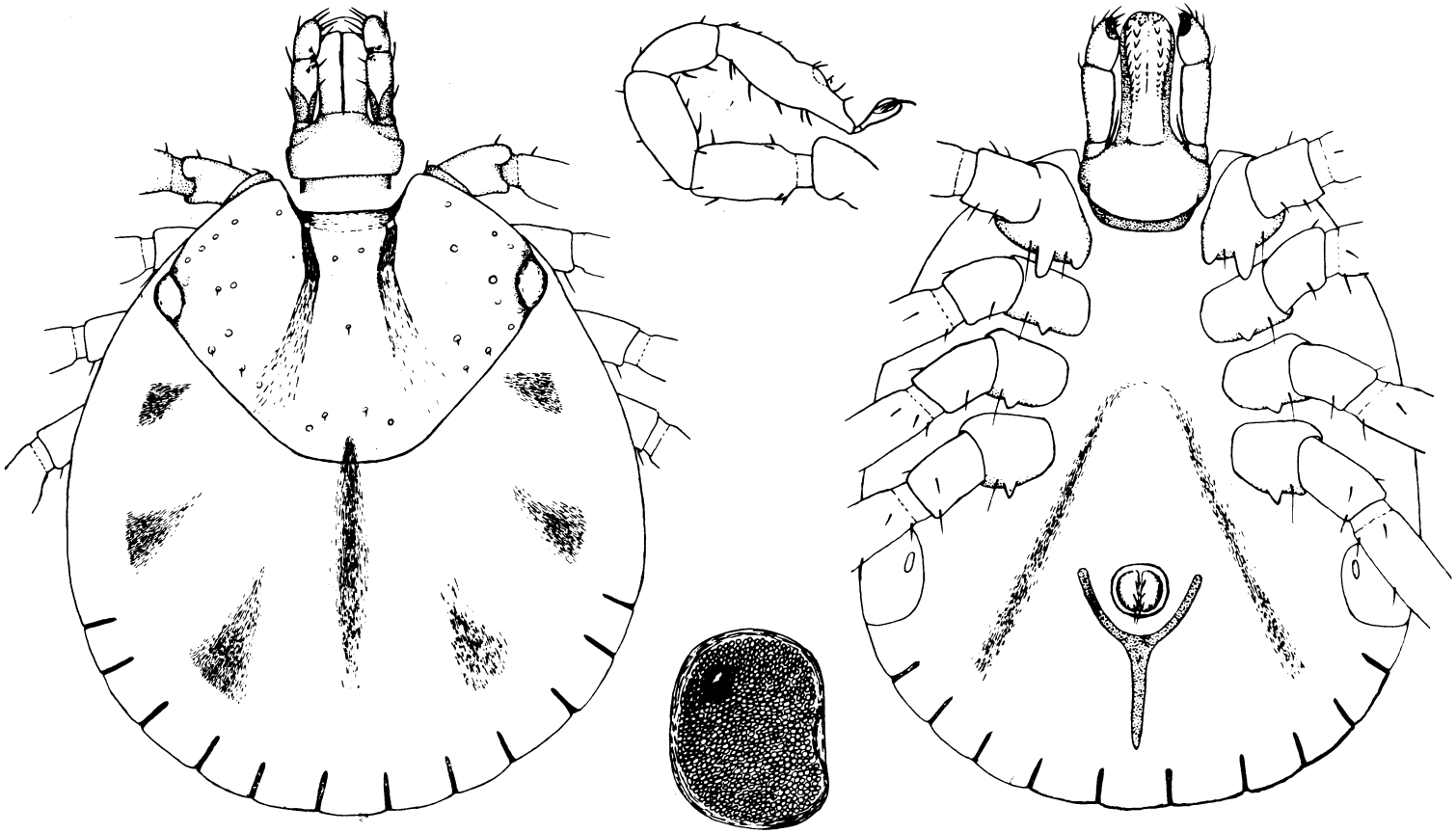


Dorsal

FEMALE

Ventral

Amblyomma americanum

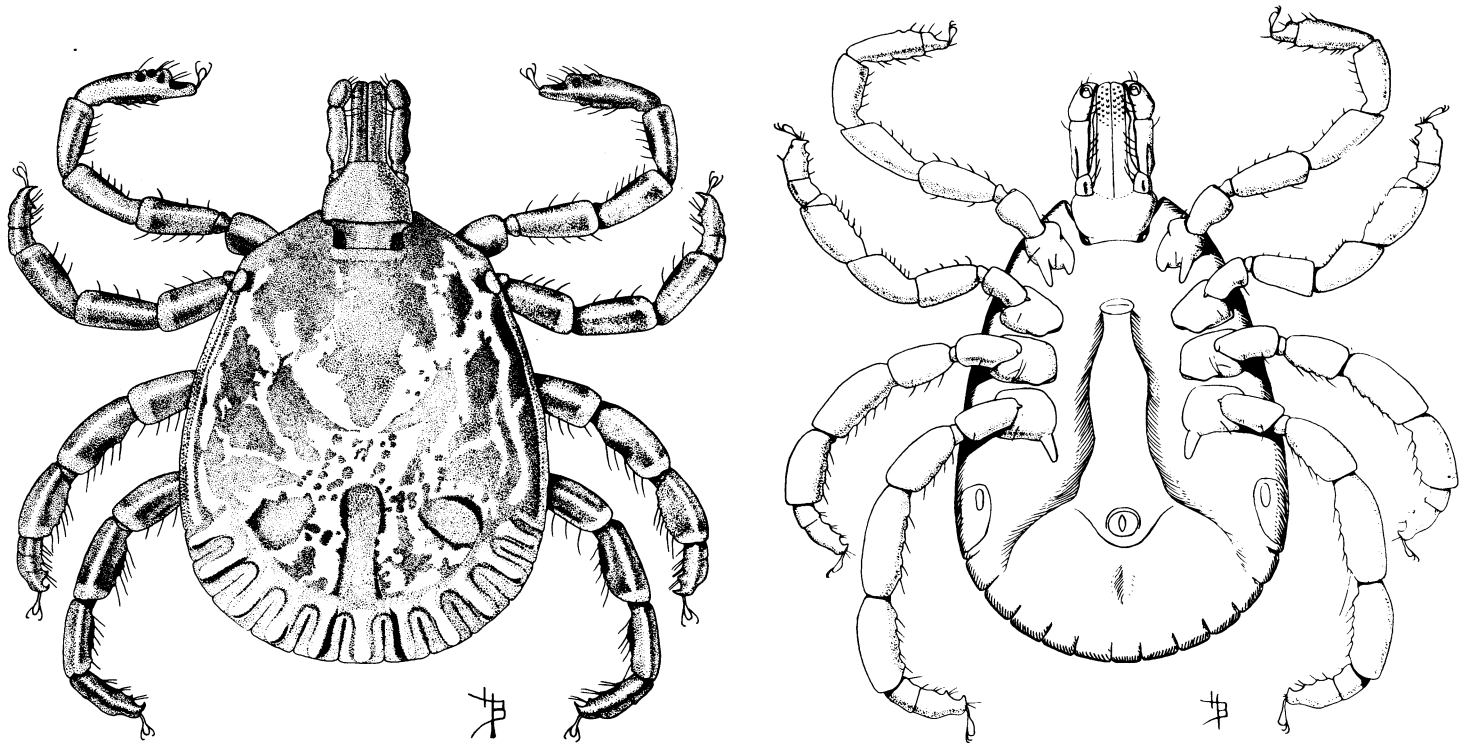


Dorsal

NYMPH

Ventral

Amblyomma americanum

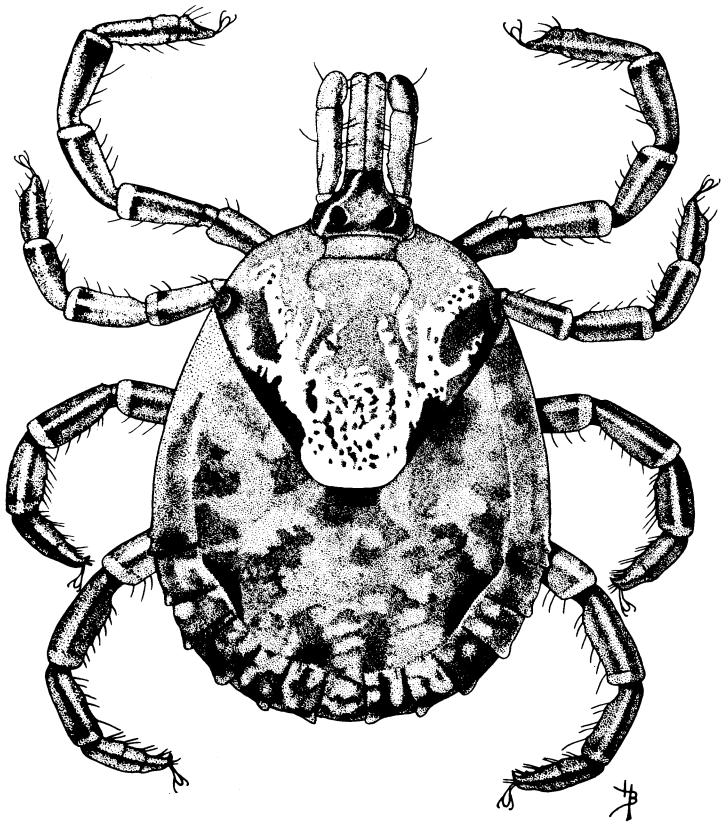


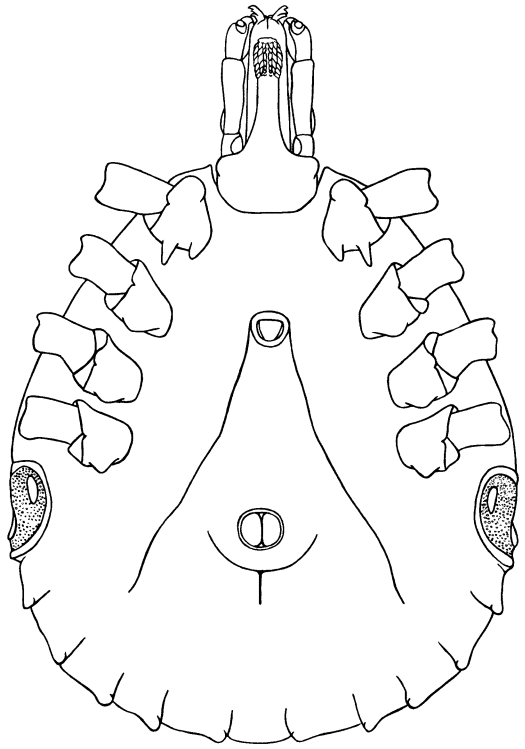
Dorsal

MALE

Ventral

Amblyomma cajennense



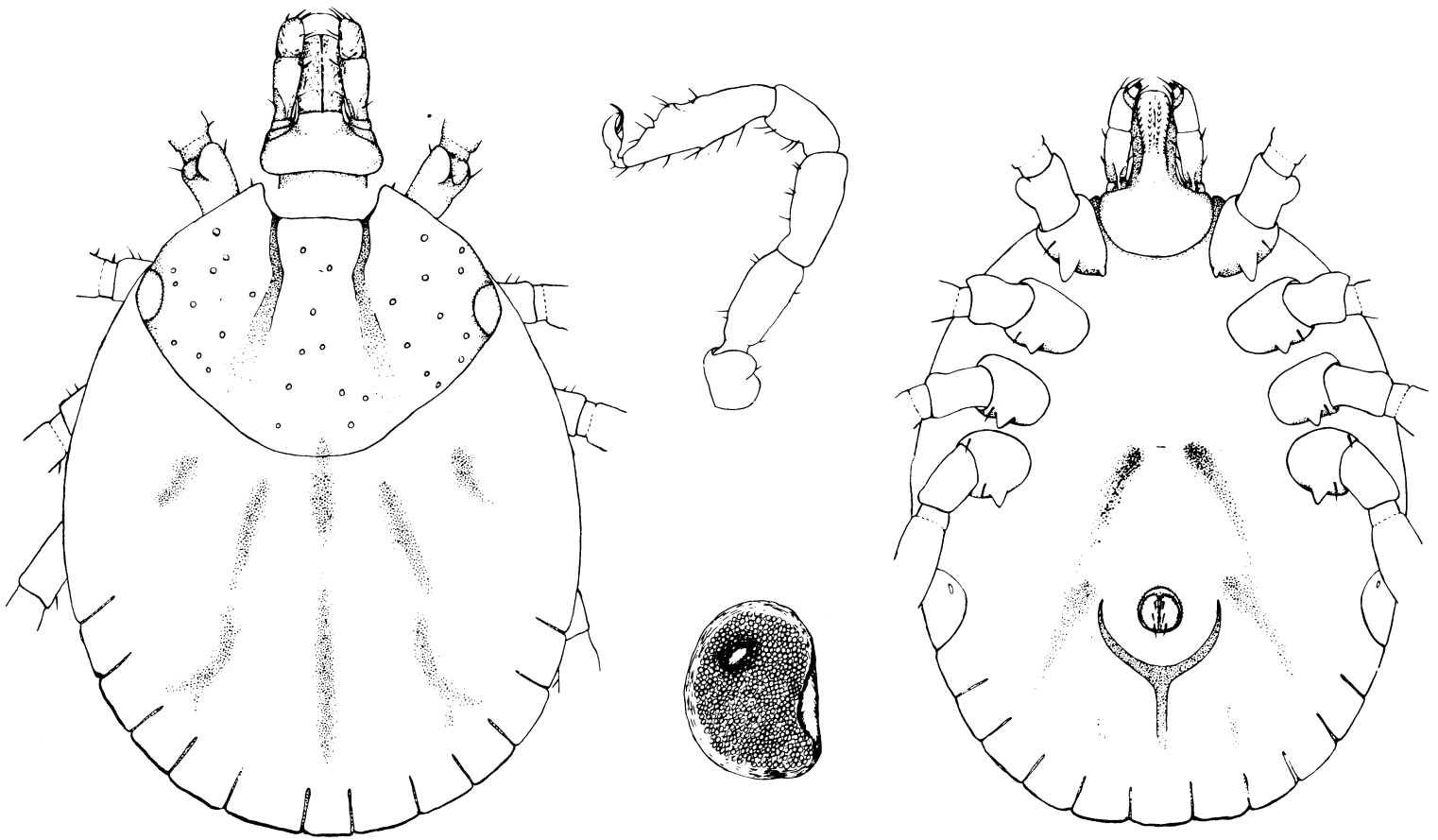


Dorsal

FEMALE

Ventral

Amblyomma cajennense

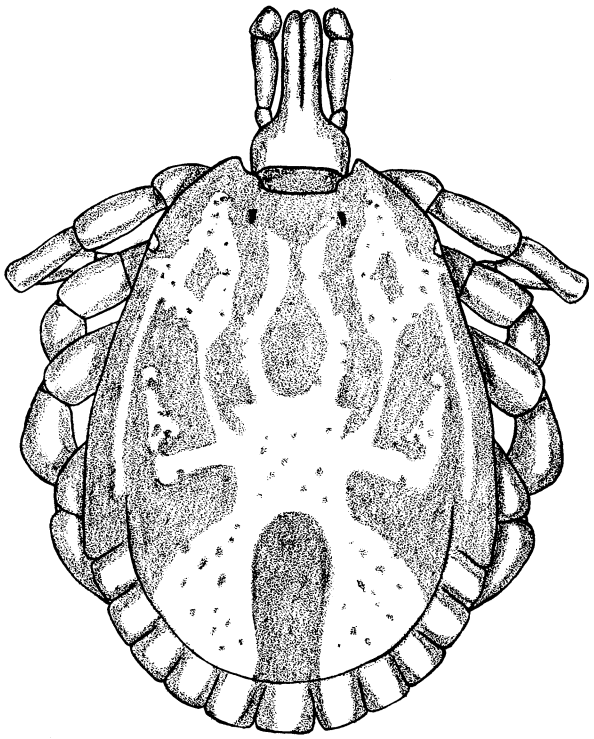


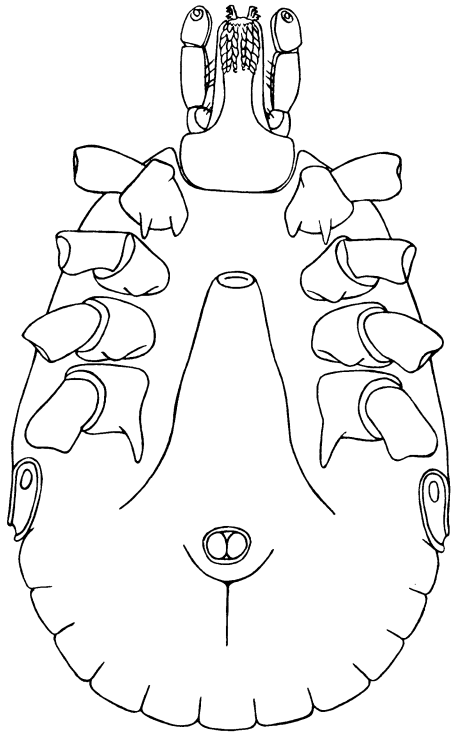
Dorsal

NYMPH

Ventral

Amblyomma cajennense



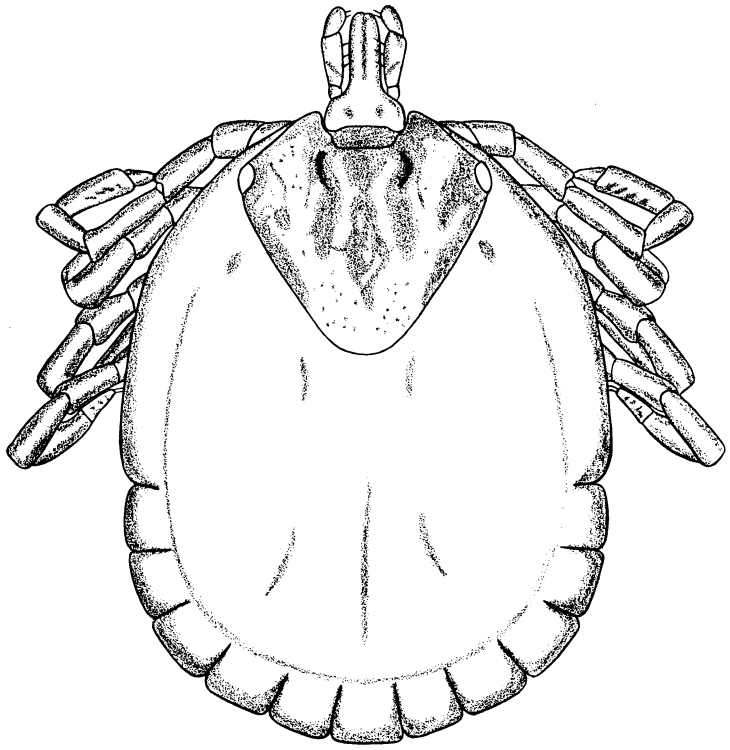


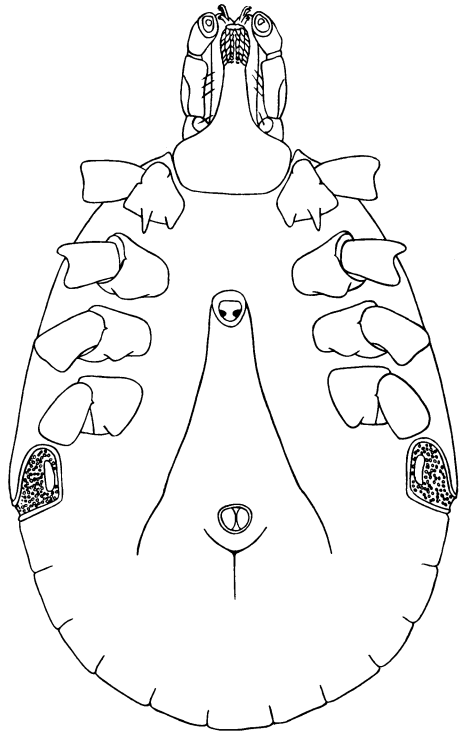
Dorsal

MALE

Ventral

Amblyomma imitator



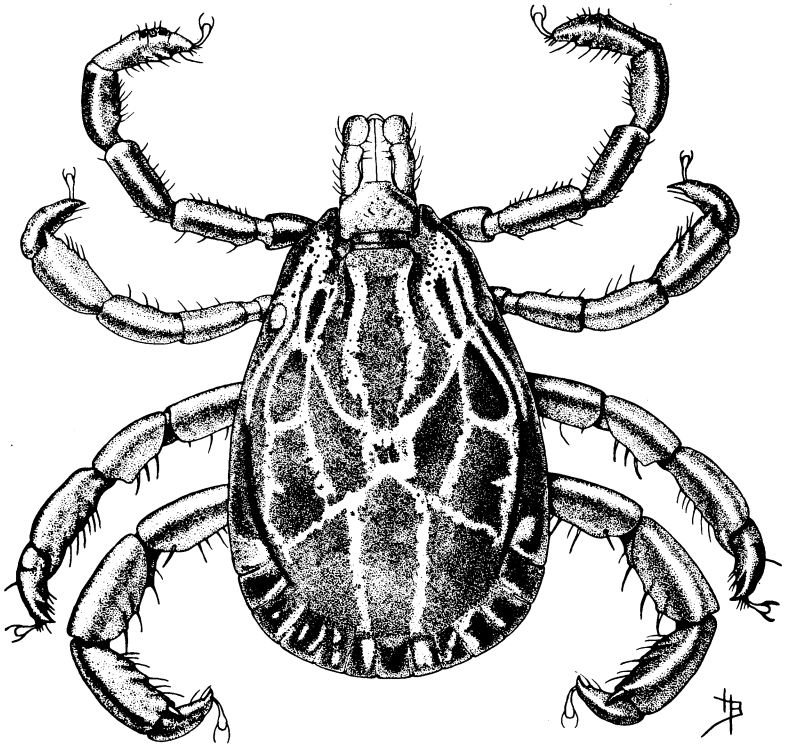


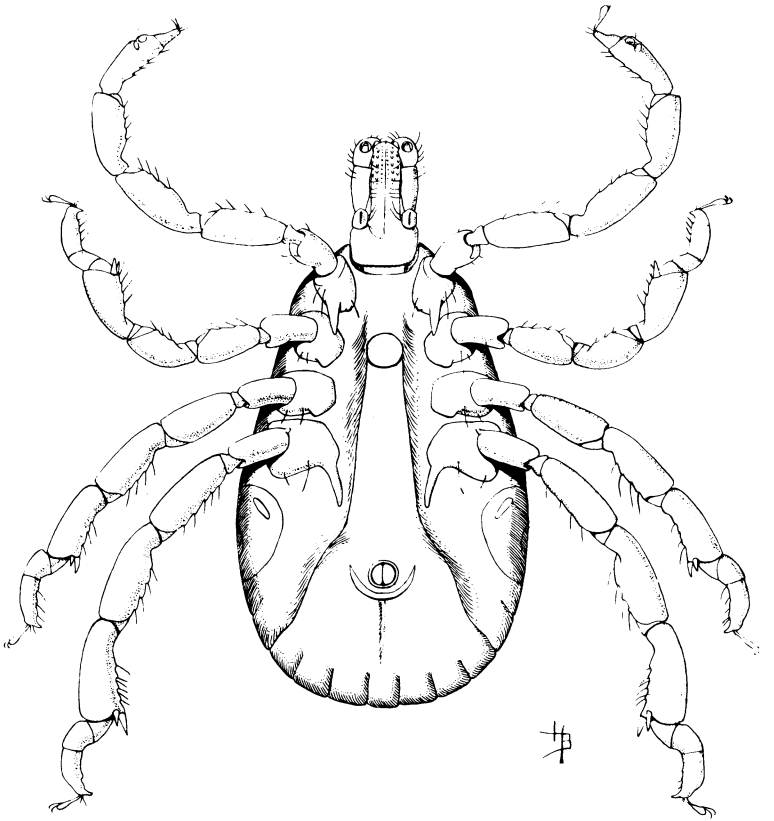
Dorsal

FEMALE

Amblyomma imitator

Ventral



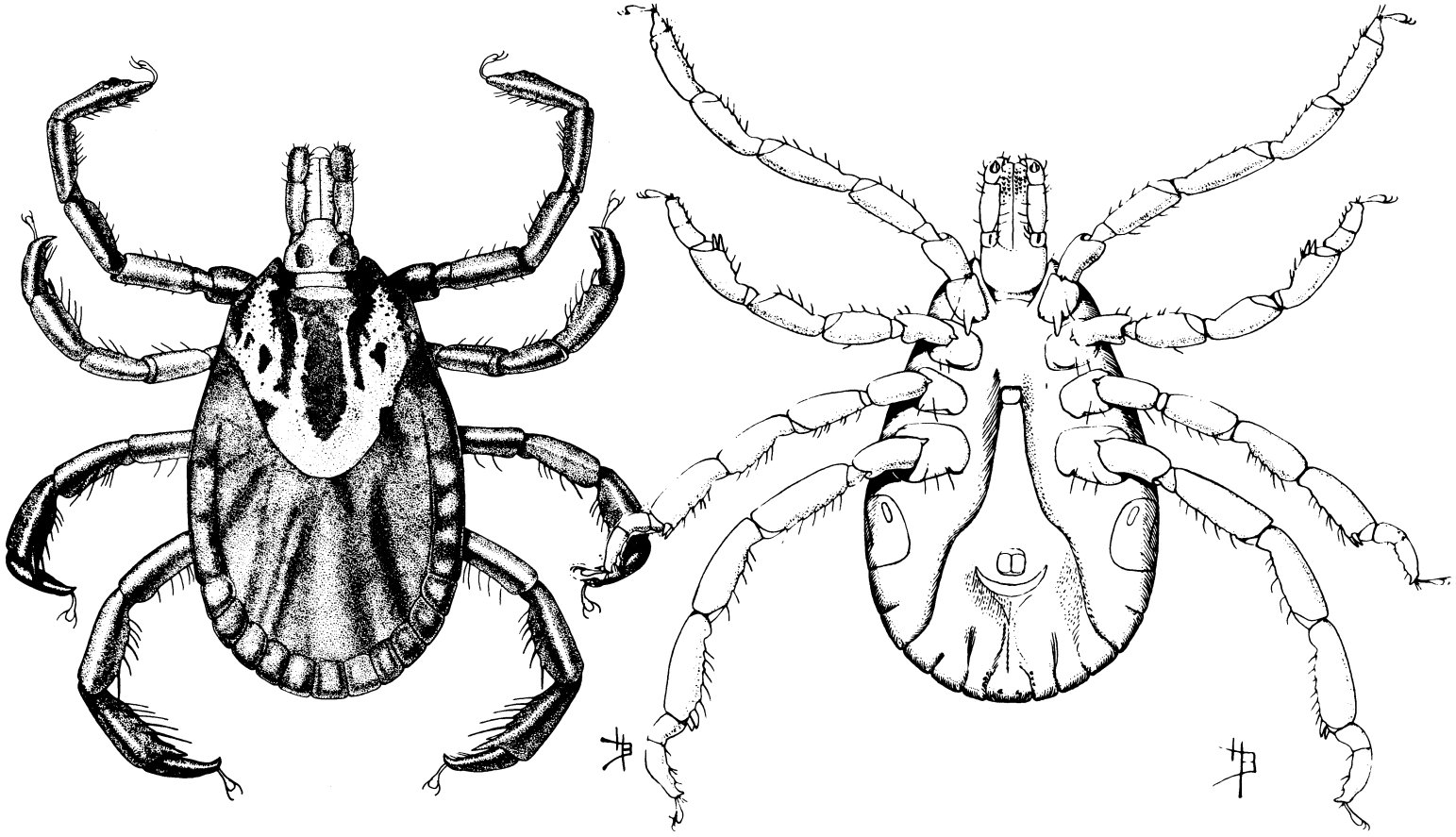


Dorsal

MALE

Ventral

Amblyomma maculatum

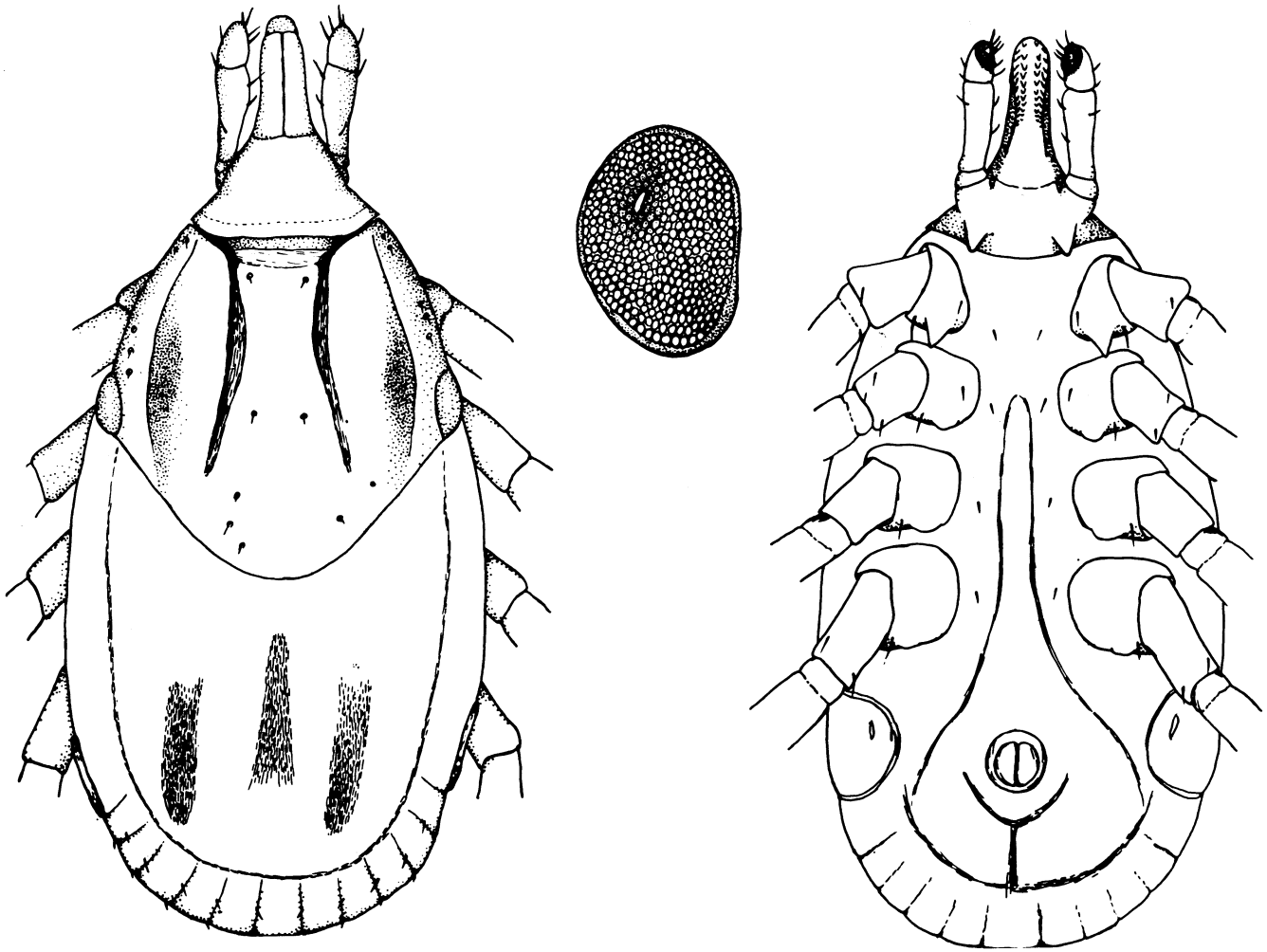


Dorsal

FEMALE

Ventral

Amblyomma maculatumm

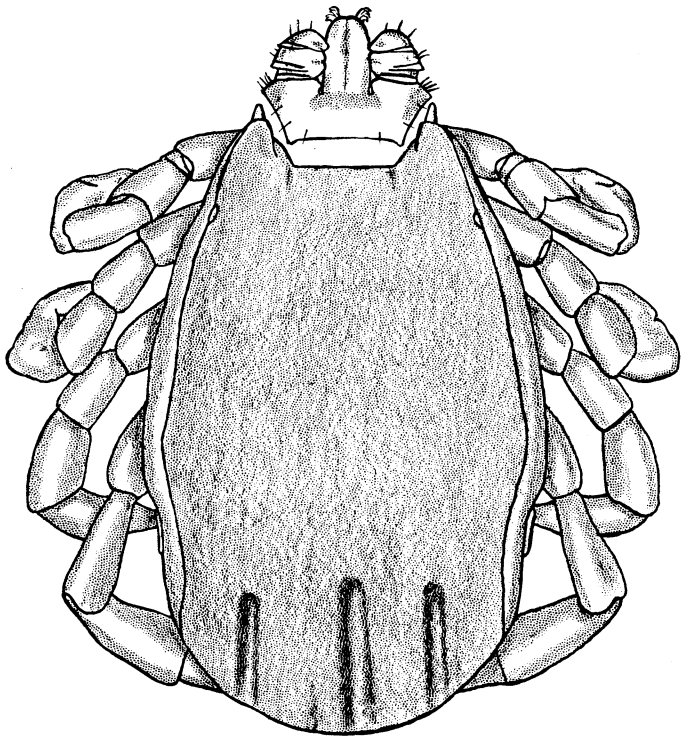


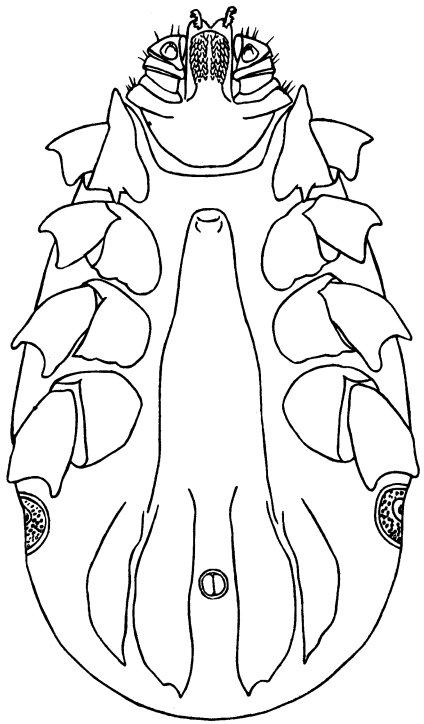
Dorsal

NYMPH

Ventral

Amblyomma maculatum



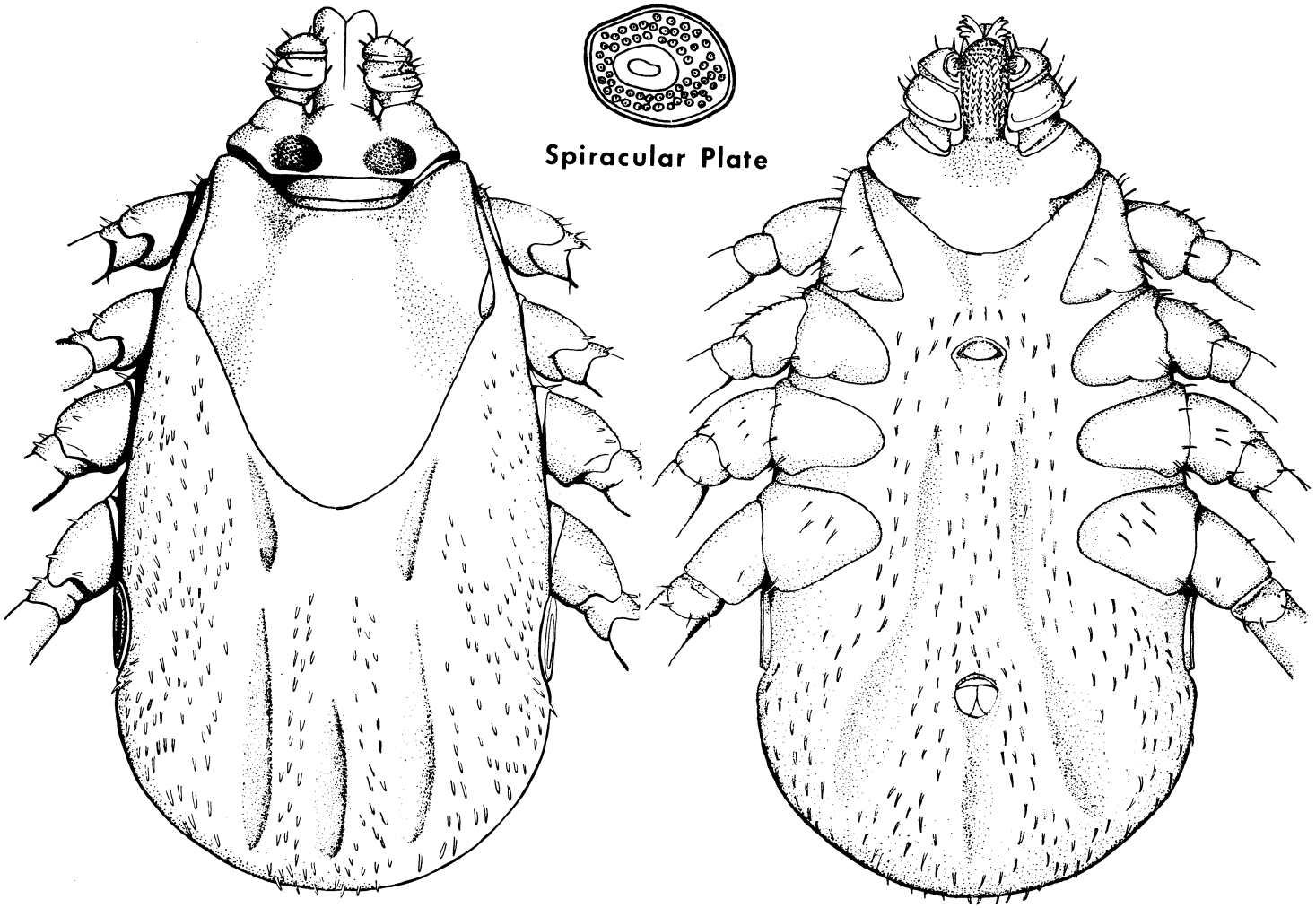


Dorsal

MALE

Ventral

Boophilus annulatus

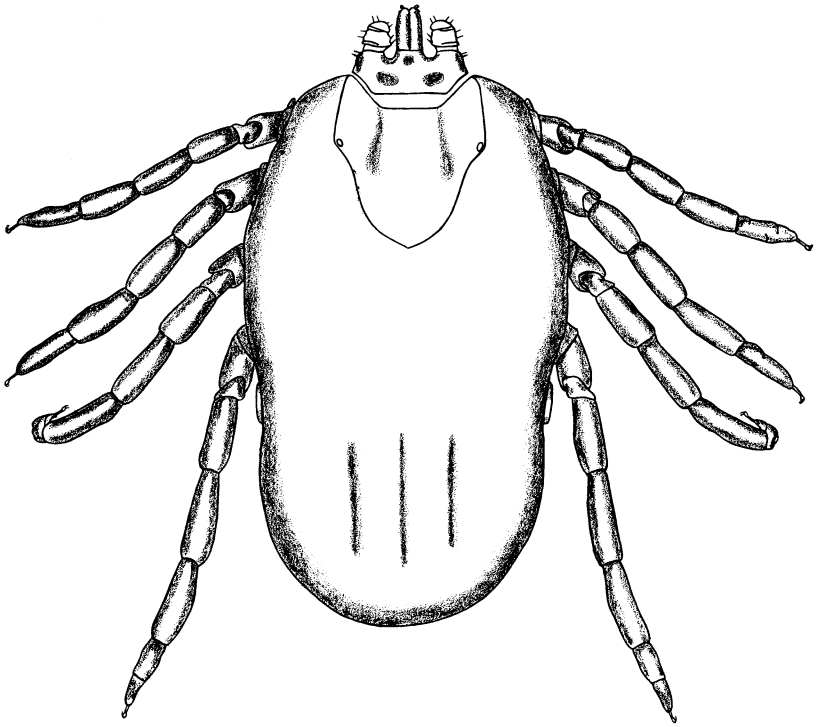


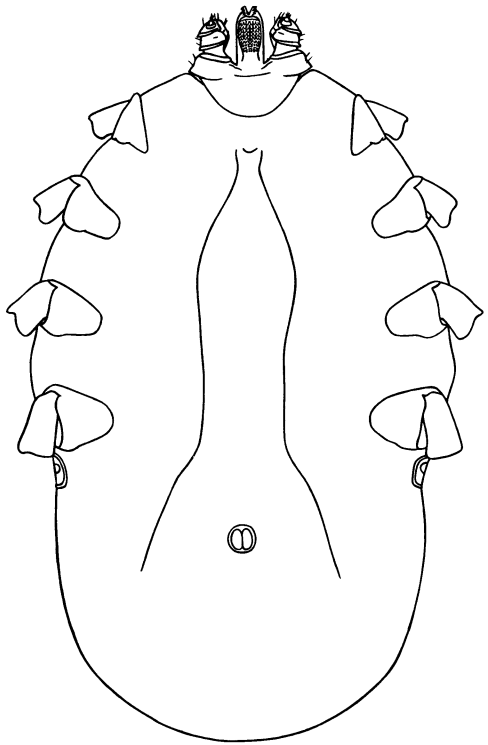
Dorsal

UNENGORGED FEMALE

Ventral

Boophilus annulatus



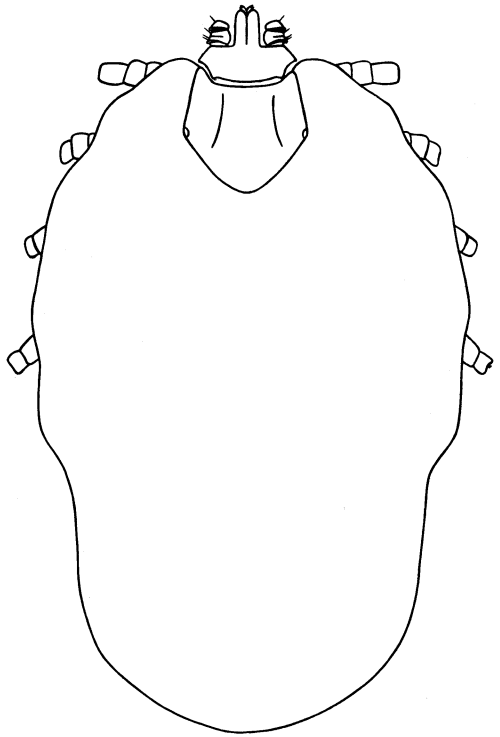


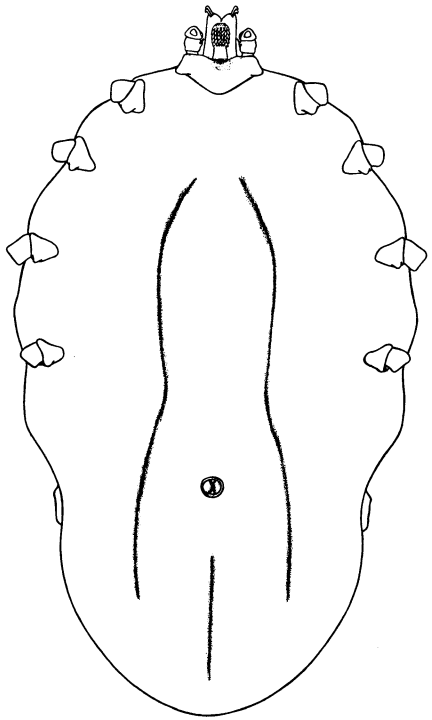
Dorsal

PARTIALLY ENGORGED FEMALE

Boophilus annulatus

Ventral



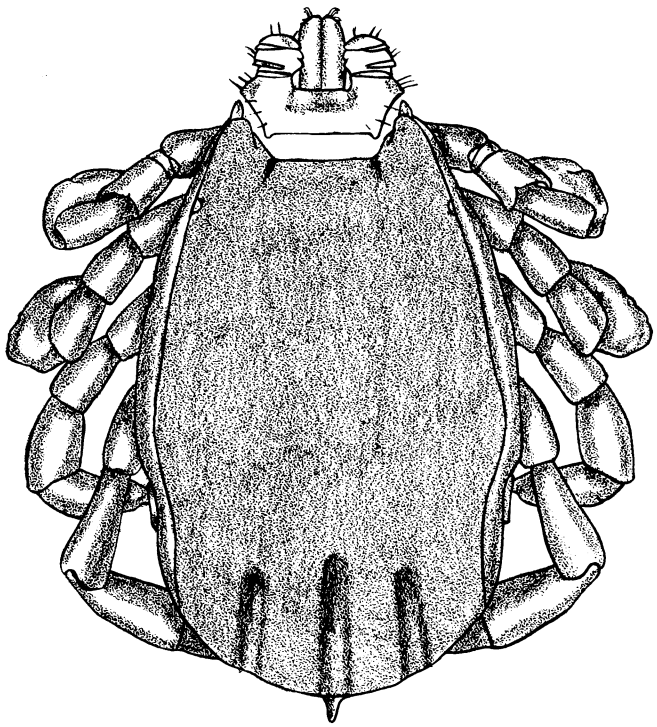


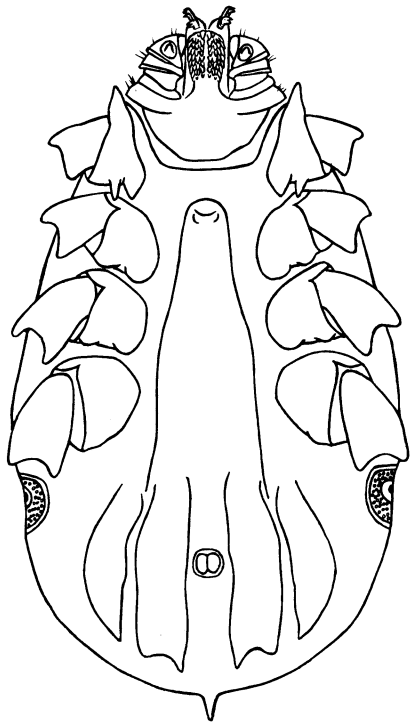
Dorsal

ENGORGED NYMPH

Boophilus annulatus

Ventral



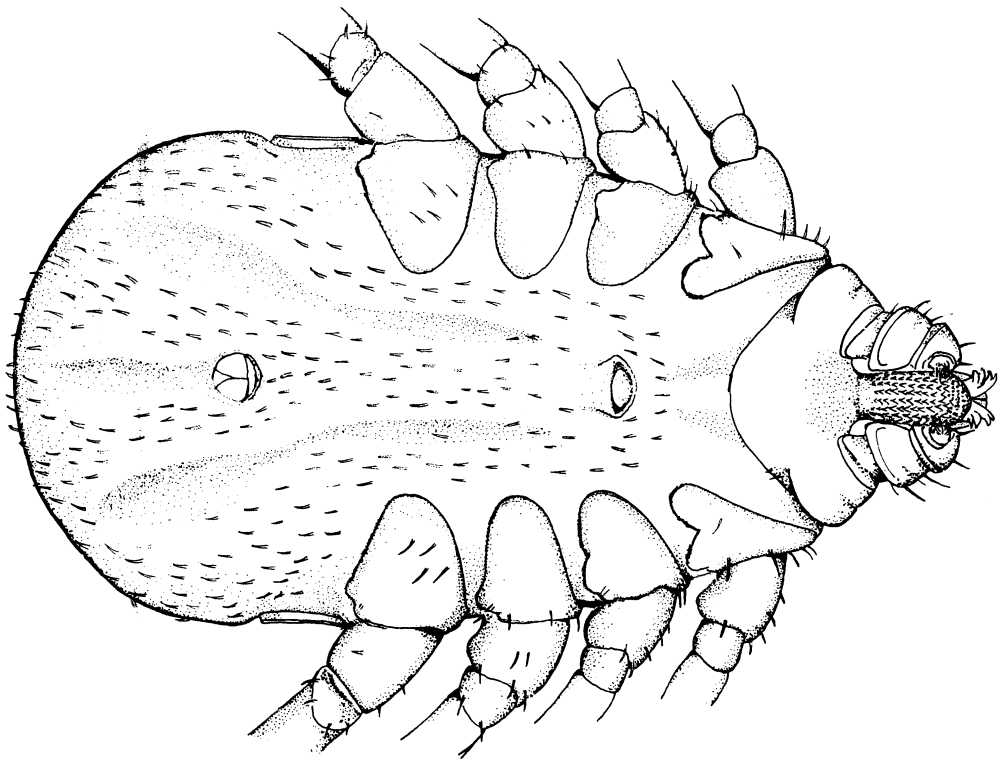


Dorsal

MALE

Ventral

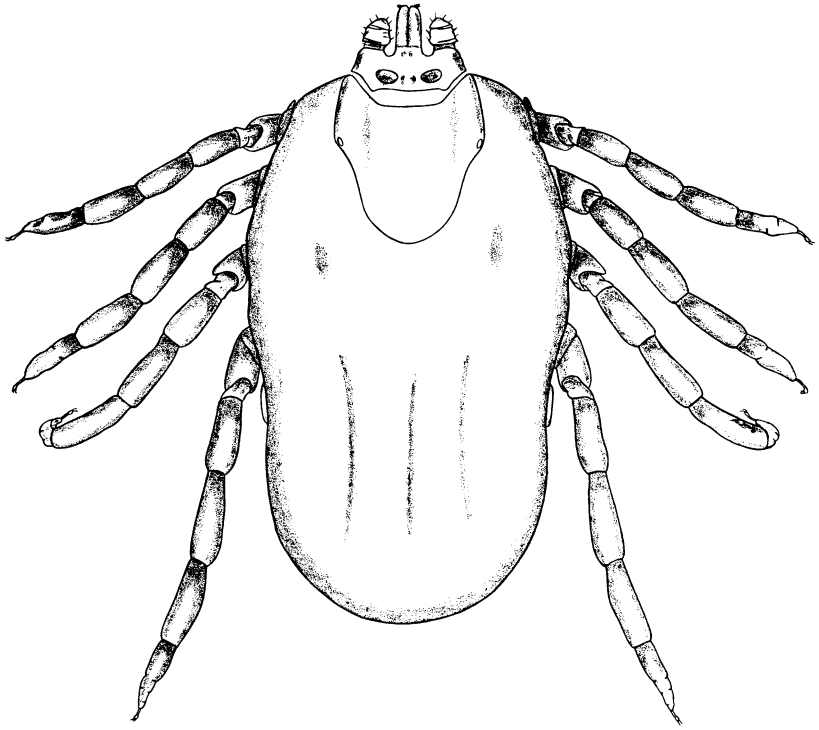
Boophilus microplus

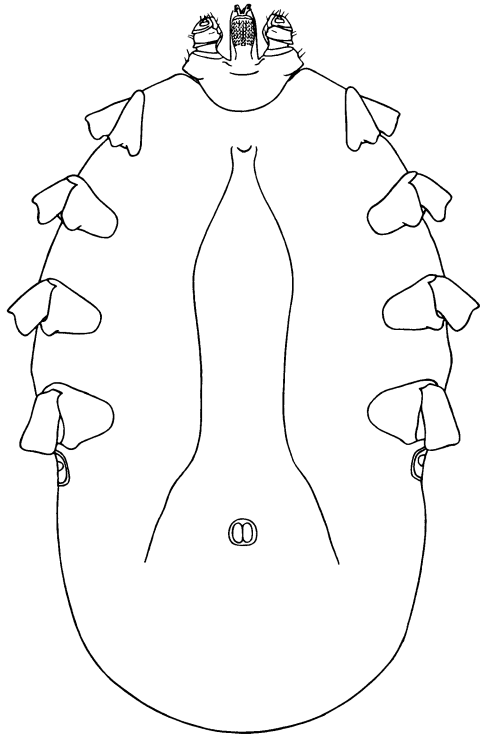


FEMALE

Boophilus microplus

Ventral



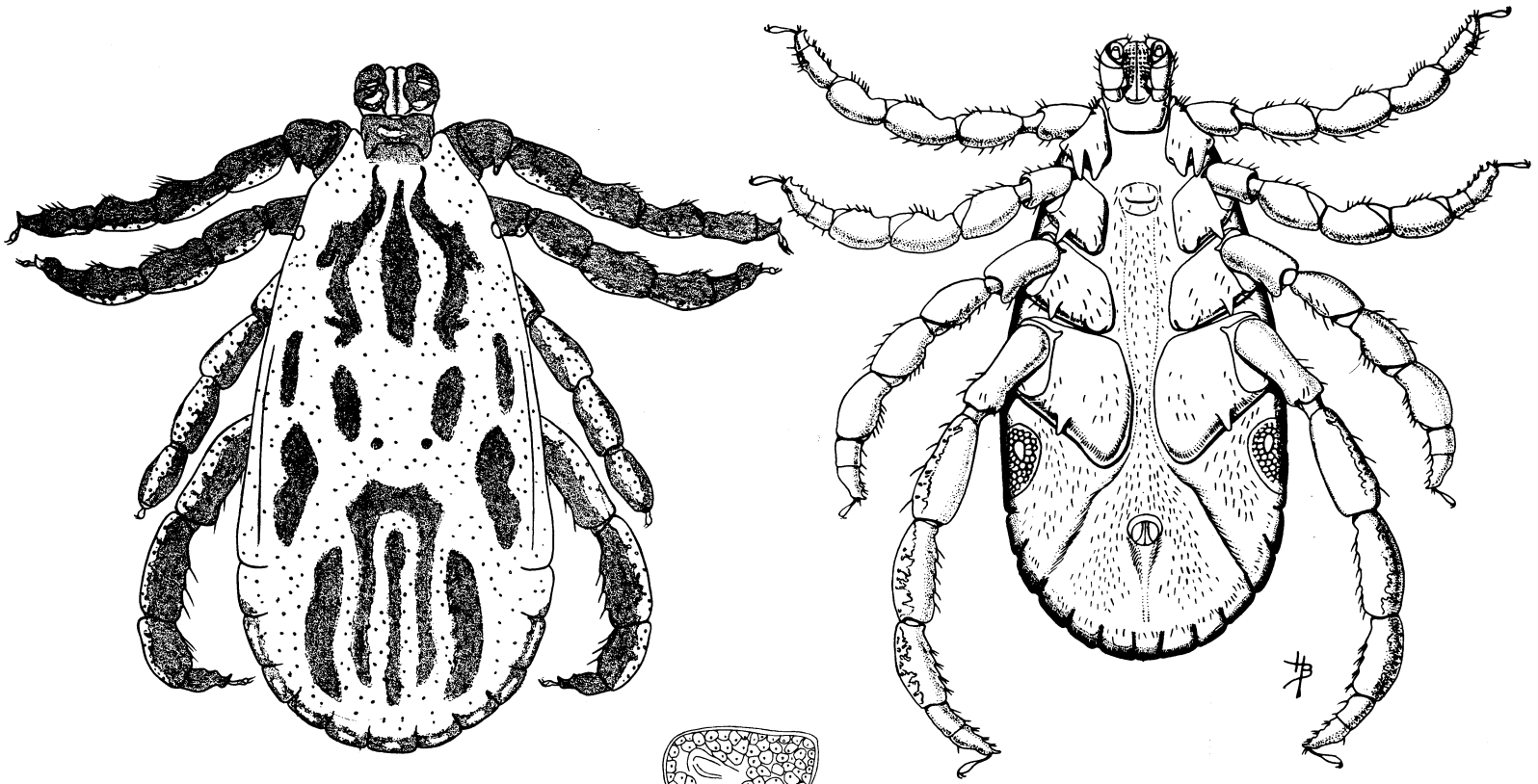


Dorsal

PARTIALLY ENGORGED FEMALE

Ventral

Boophilus microplus



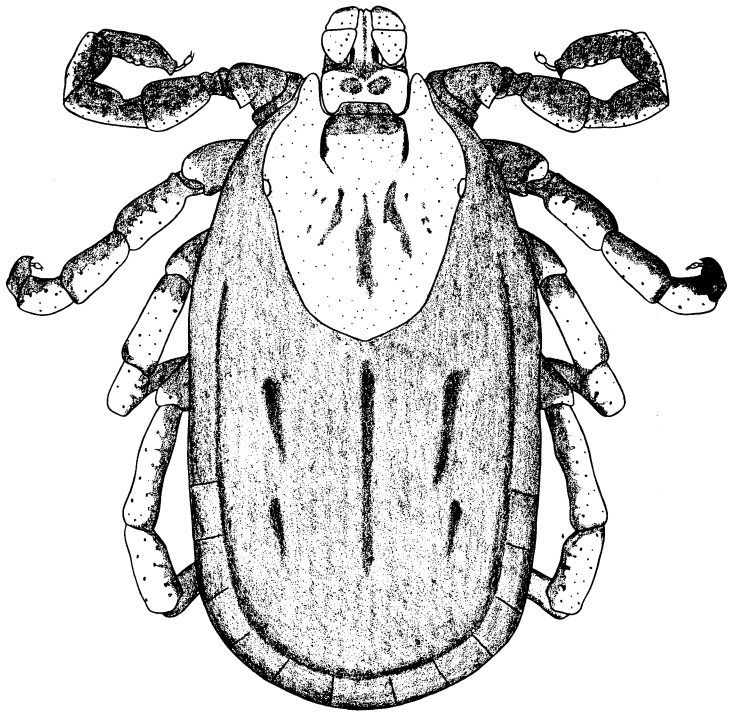
Spiracular Plate

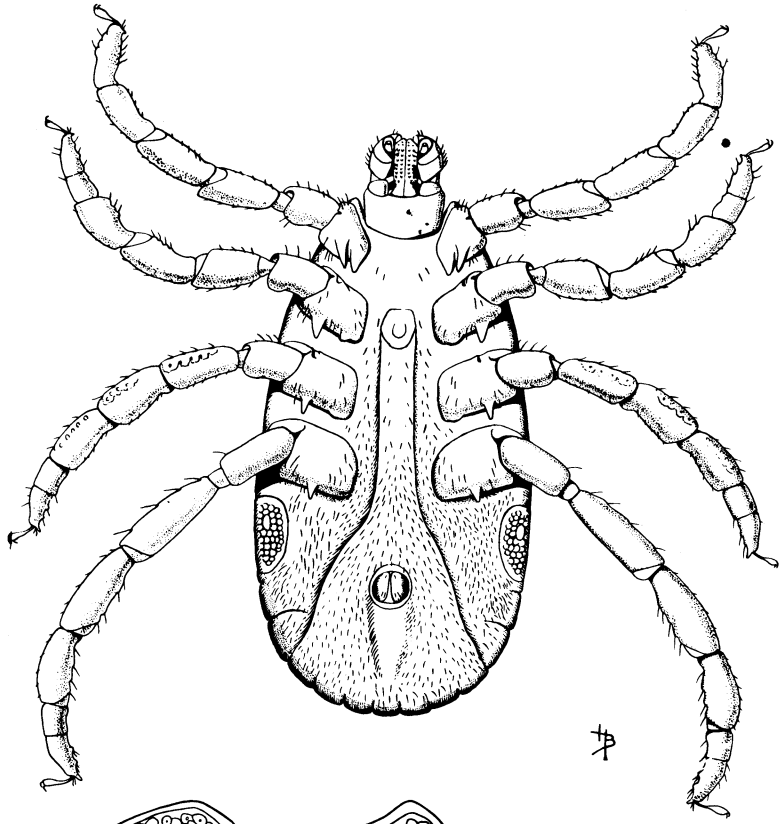
Dorsal

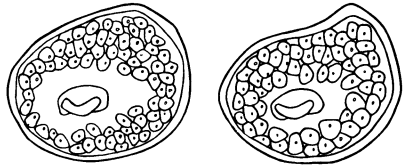
MALE

Ventral

Dermacentor albipictus







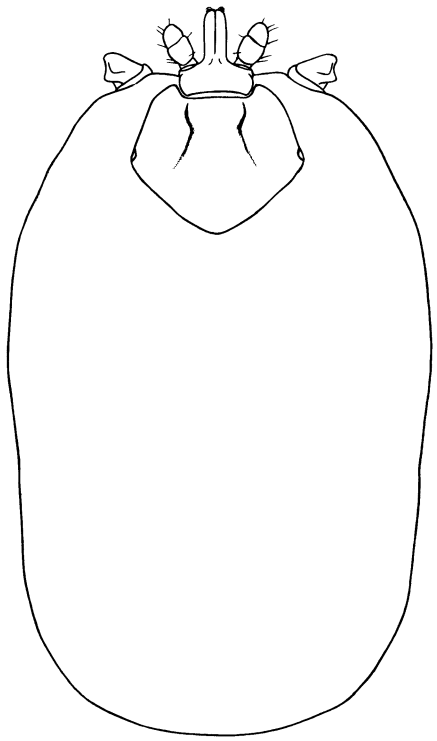
Spiracular Plate

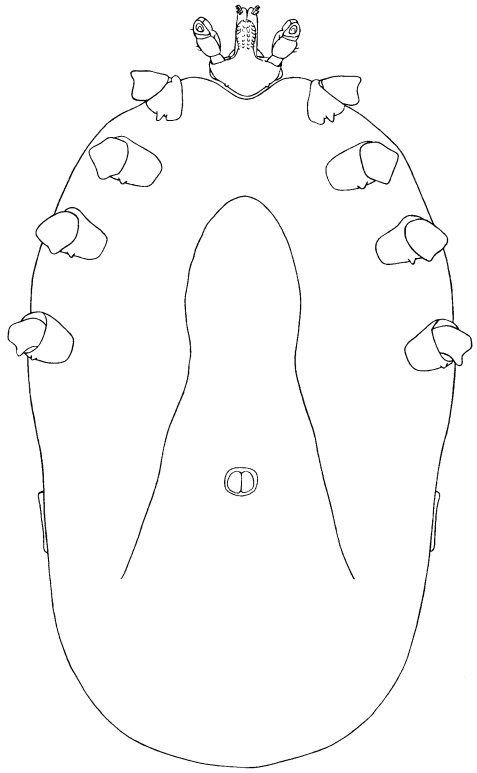
Dorsal

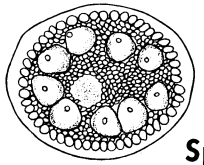
FEMALE

Ventral

Dermacentor albipictus







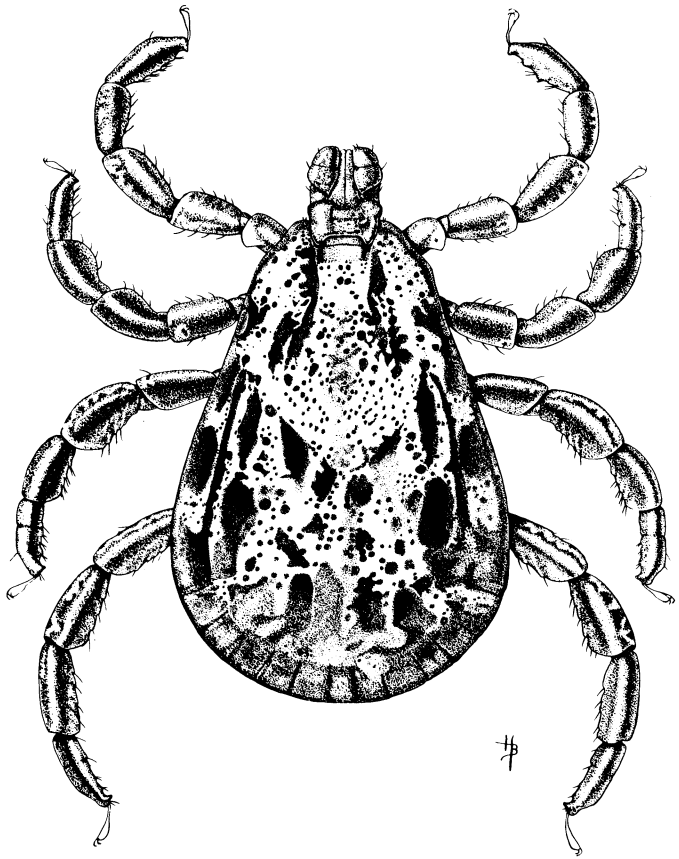
Spiracular Plate

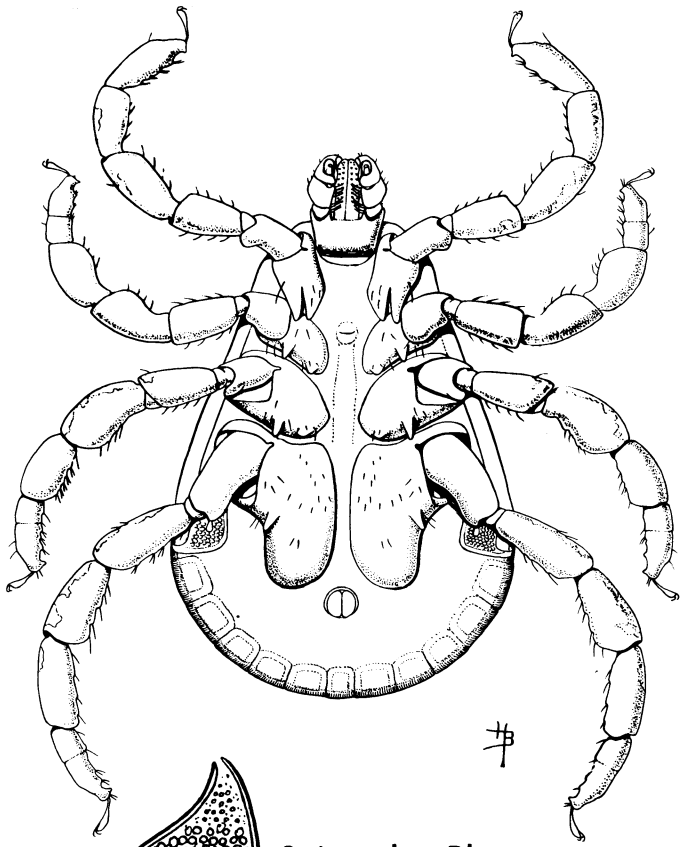
Dorsal

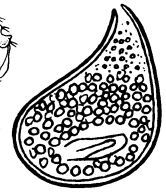
NYMPH

Ventral

Dermacentor albipictus







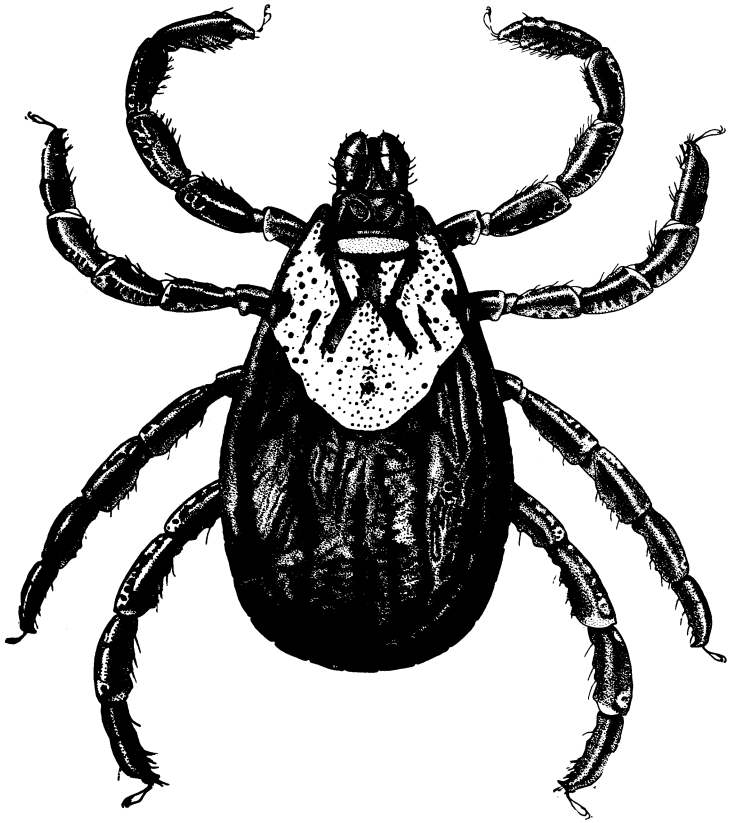
Spiracular Plate

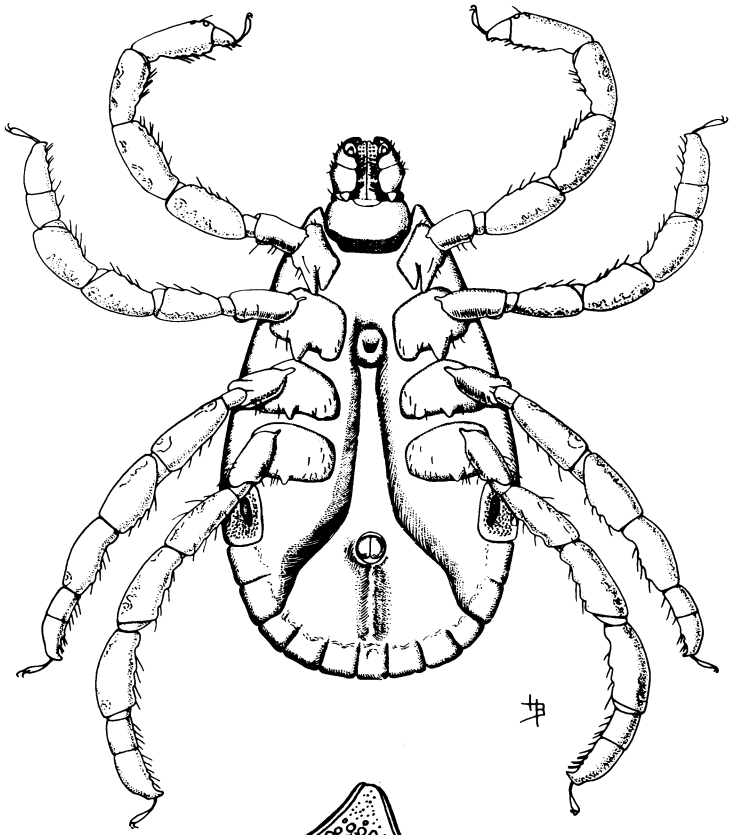
Dorsal

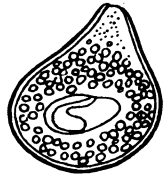
MALE

Ventral

Dermacentor andersoni







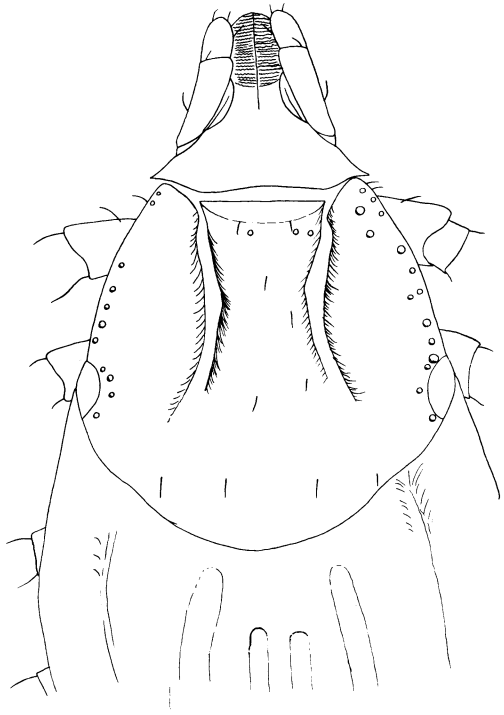
Spiracular Plate

Dorsal

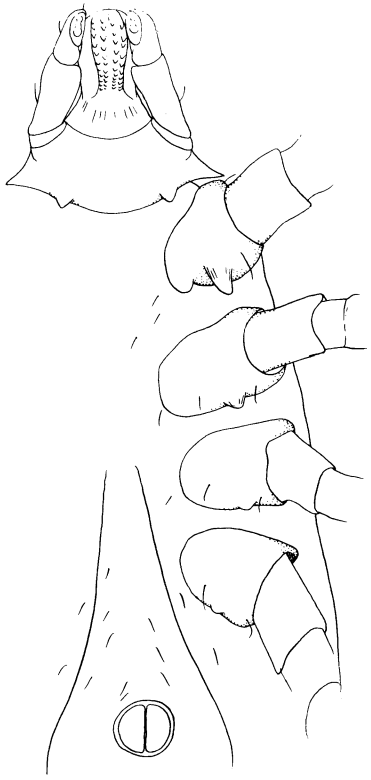
FEMALE

Ventral

Dermacentor andersoni



Spiracular Plate

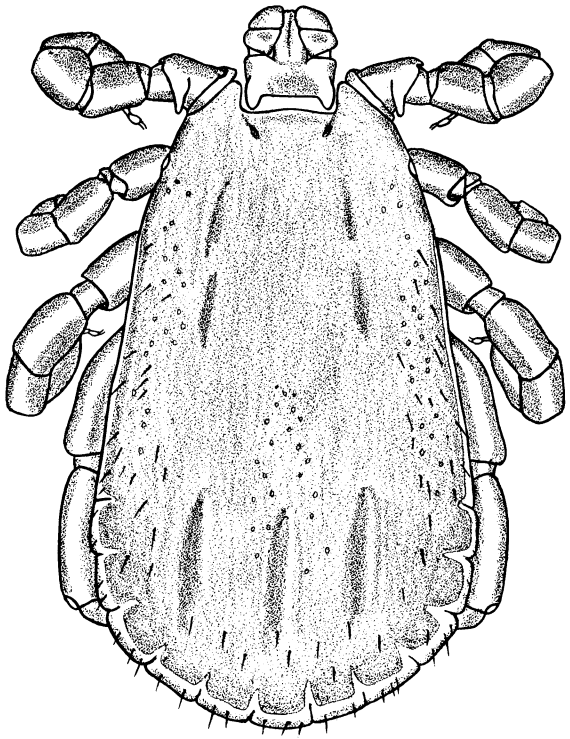


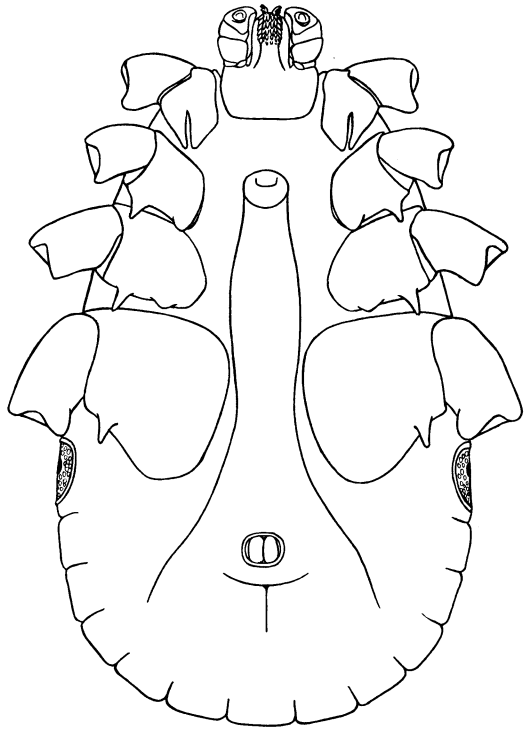
Dorsal

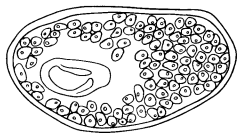
NYMPH

Ventral

Dermacentor andersoni







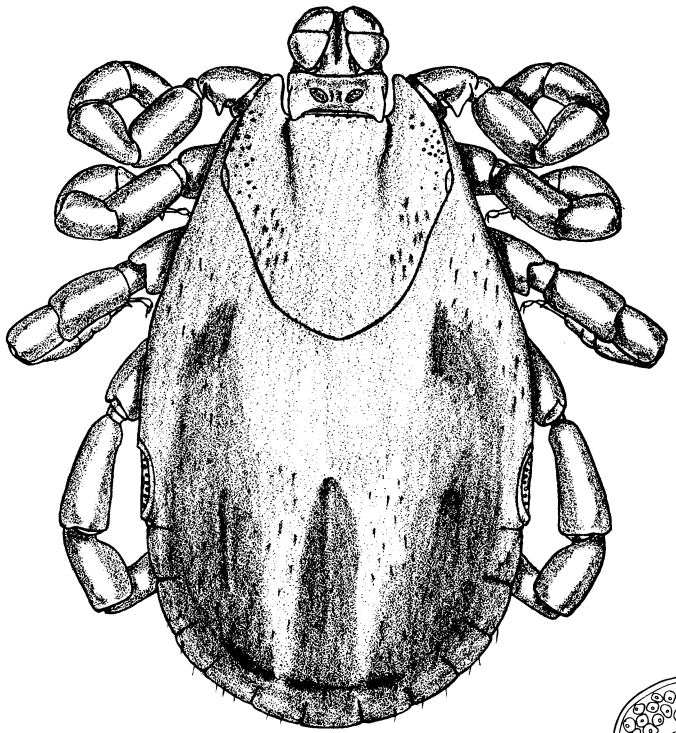
Spiracular Plate

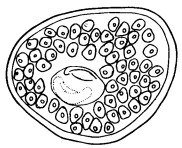
Dorsal

MALE

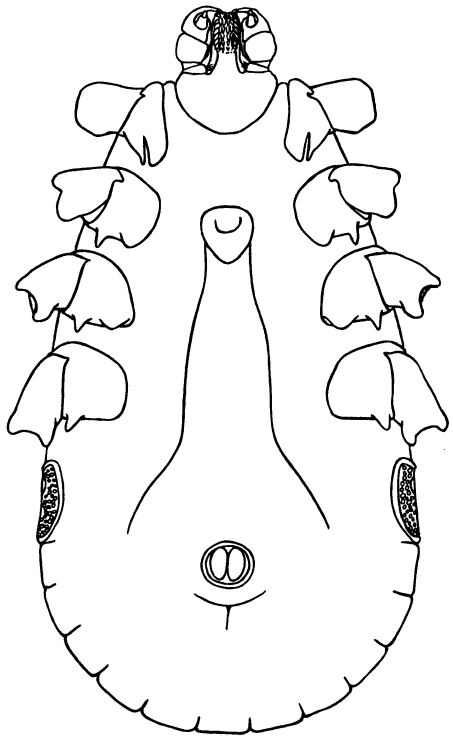
Ventral

Dermacentor nigrolineatus





Spiracular Plate

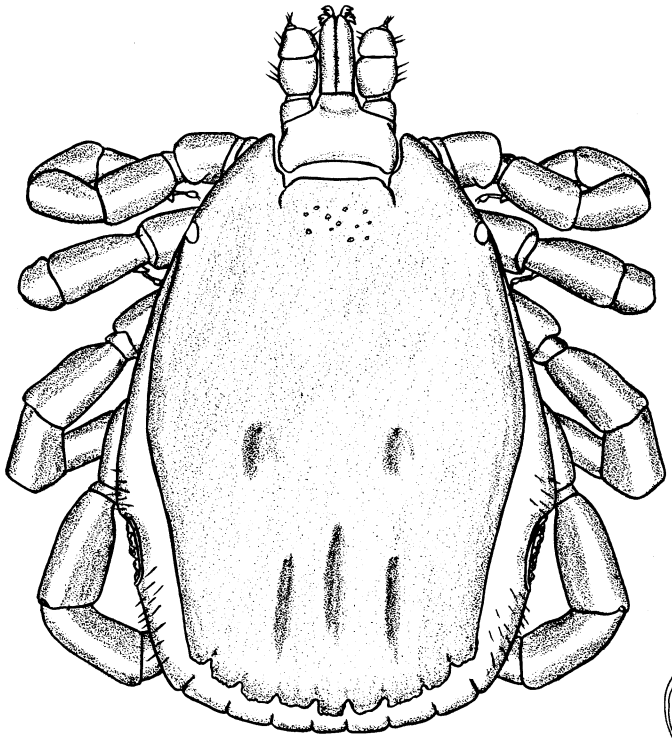


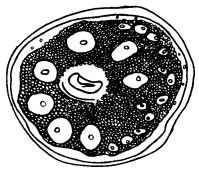
Dorsal

FEMALE

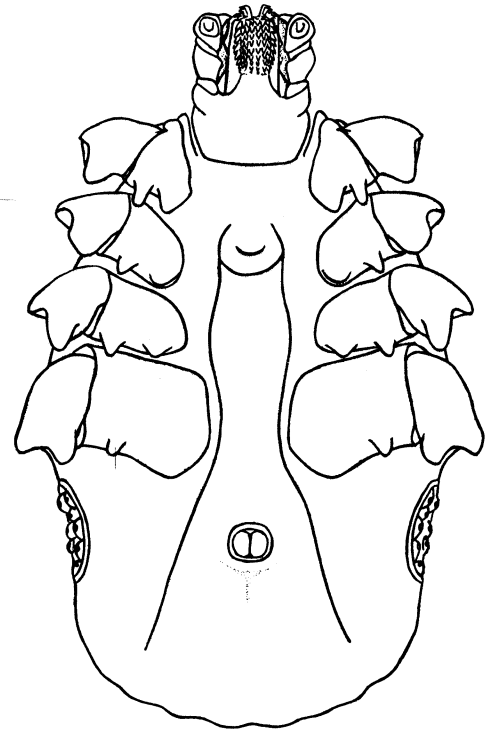
Ventral

Dermacentor nigrolineatus





Spiracular Plate

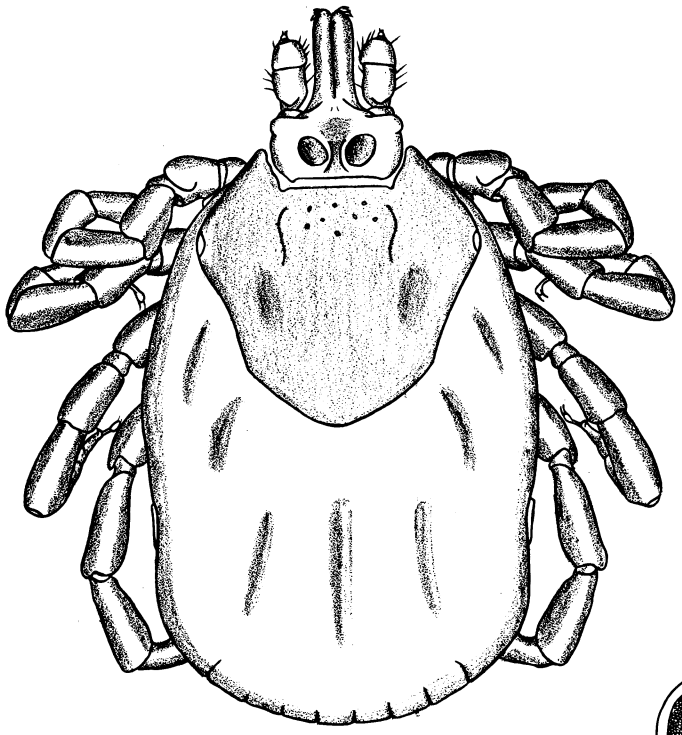


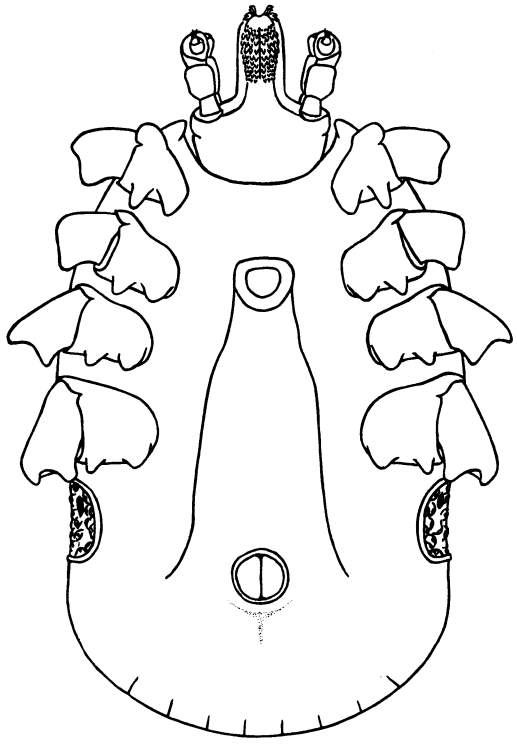
Dorsal

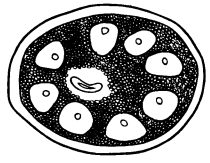
MALE

Ventral

Dermacentor nitens







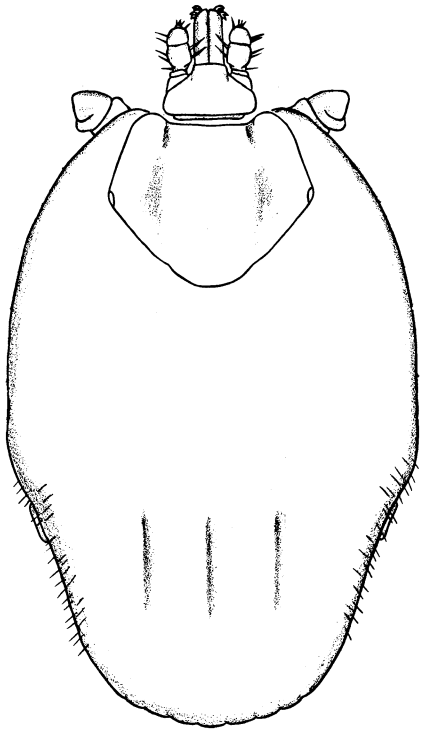
Spiracular Plate

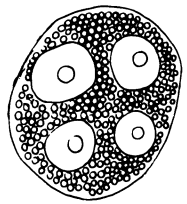
Dorsal

FEMALE

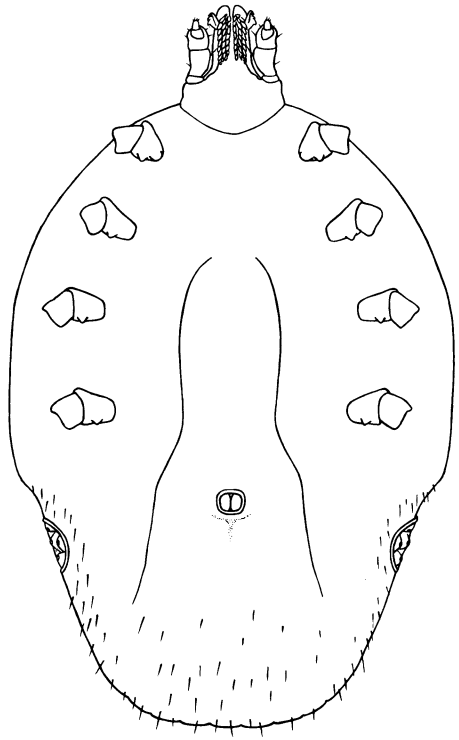
Ventral

Dermacentor nitens





Spiracular Plate



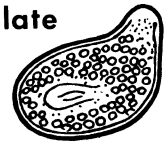
Dorsal

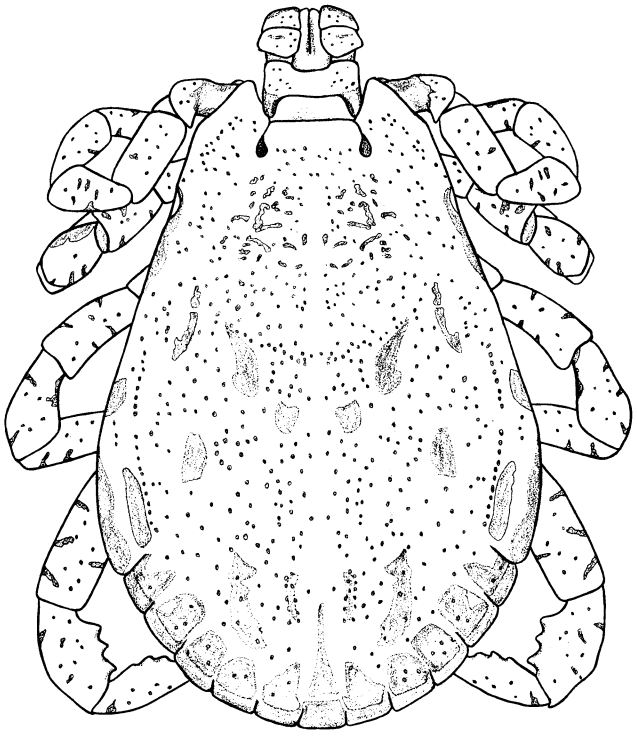
NYMPH

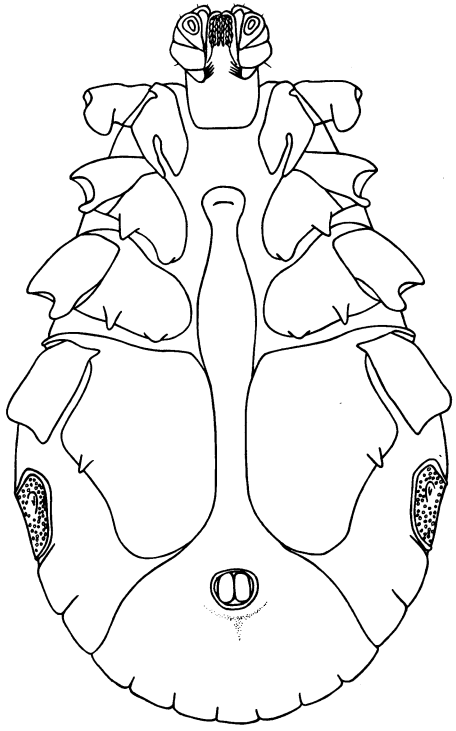
Ventral

Dermacentor nitens

Spiracular Plate







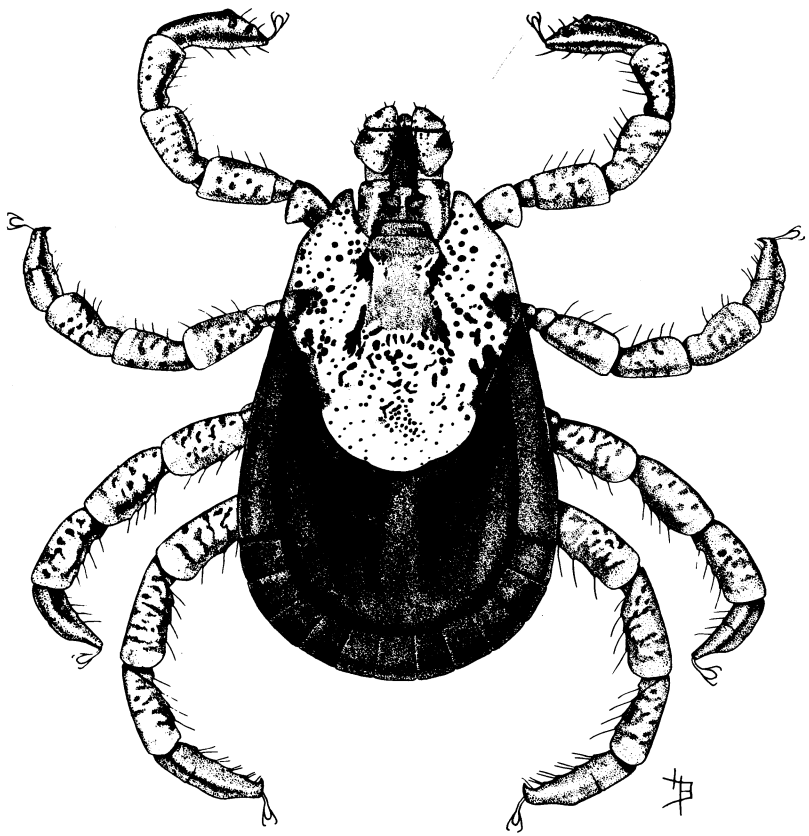
Dorsal

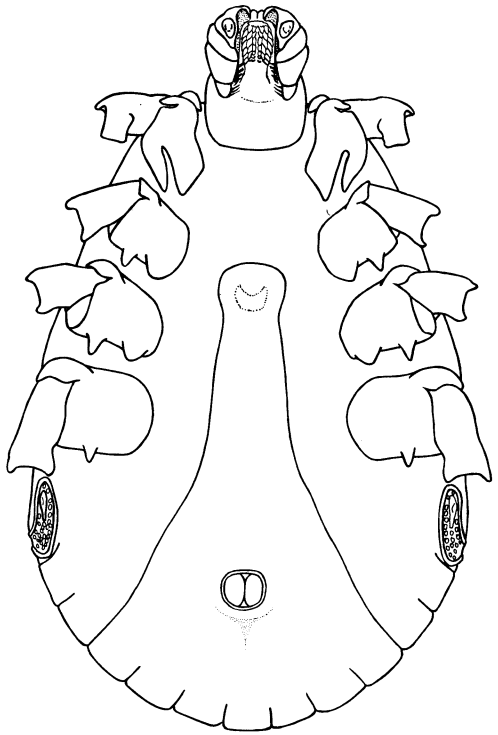
MALE

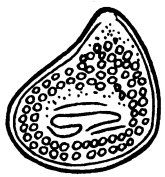
Ventral

Dermacentor occidentalis

PLATE 36







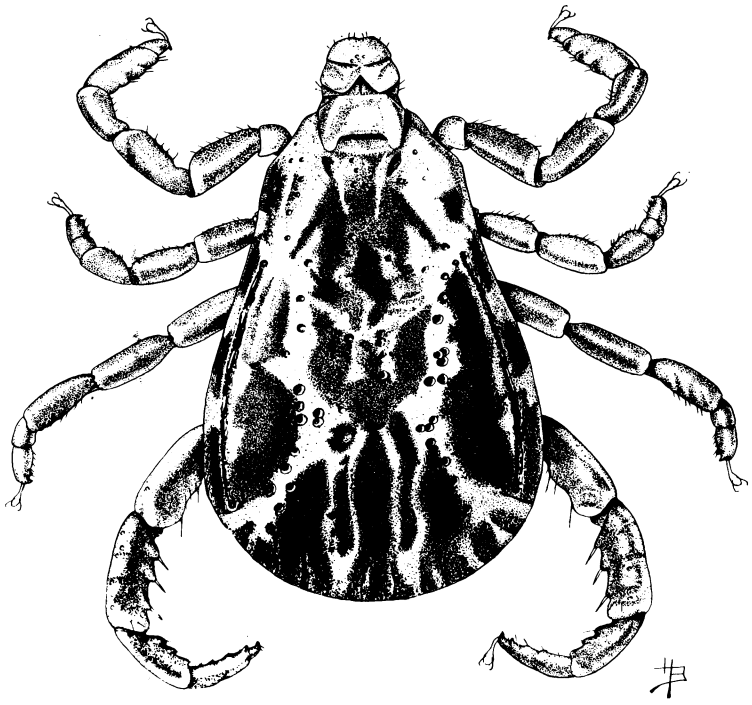
Spiracular Plate

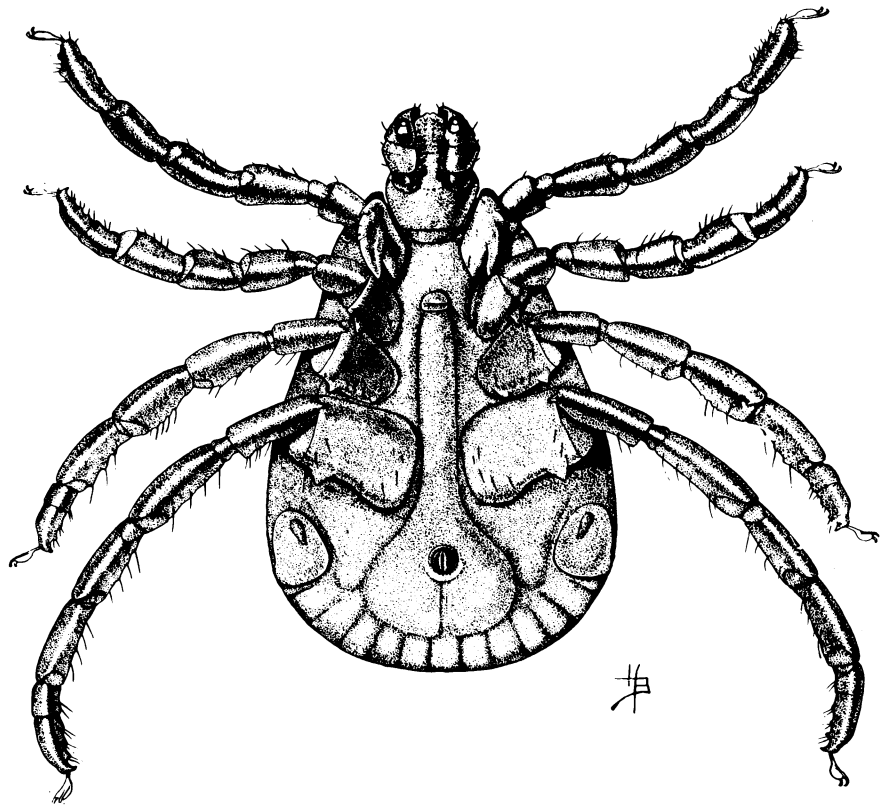
Dorsal

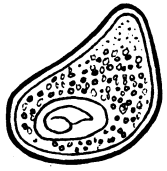
FEMALE

Ventral

Dermacentor occidentalis







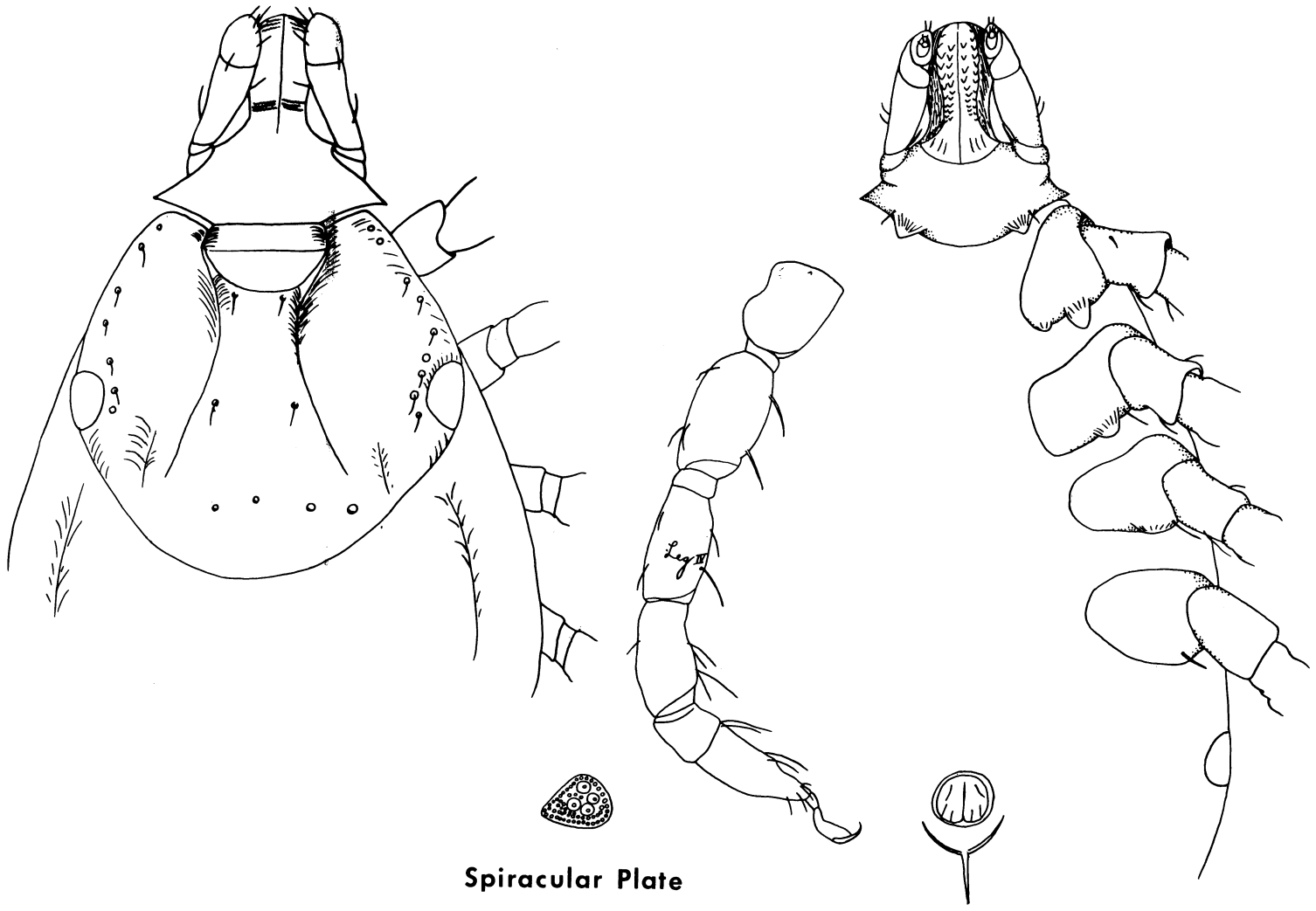
Spiracular Plate

Dorsal

MALE

Ventral

Dermacentor variabilis



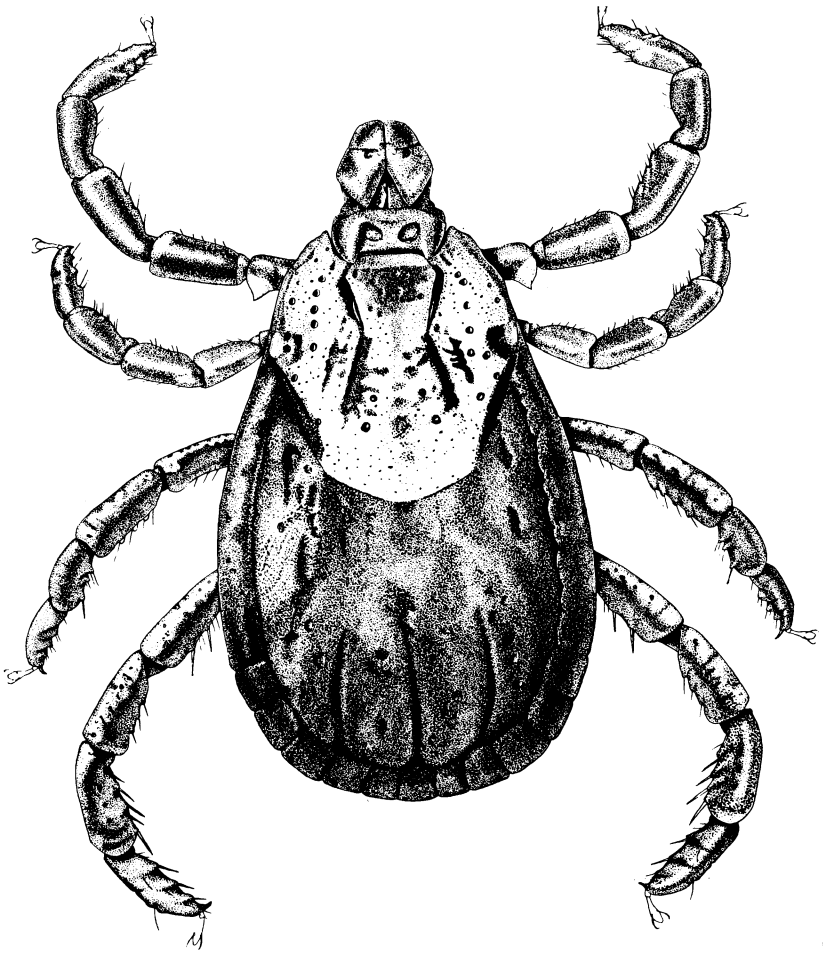
Spiracular Plate

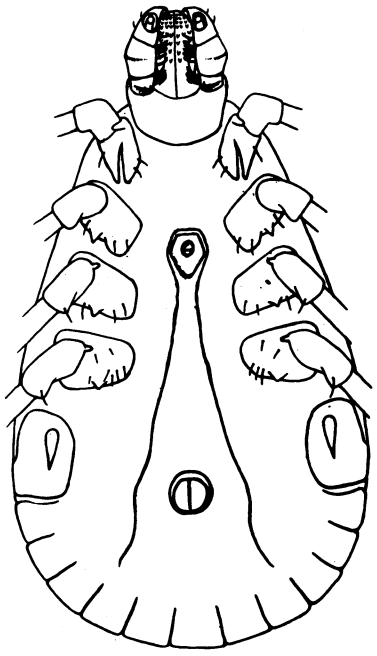
Dorsal

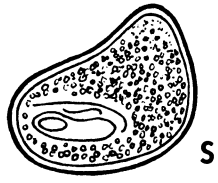
NYMPH

Ventral

Dermacentor occidentalis







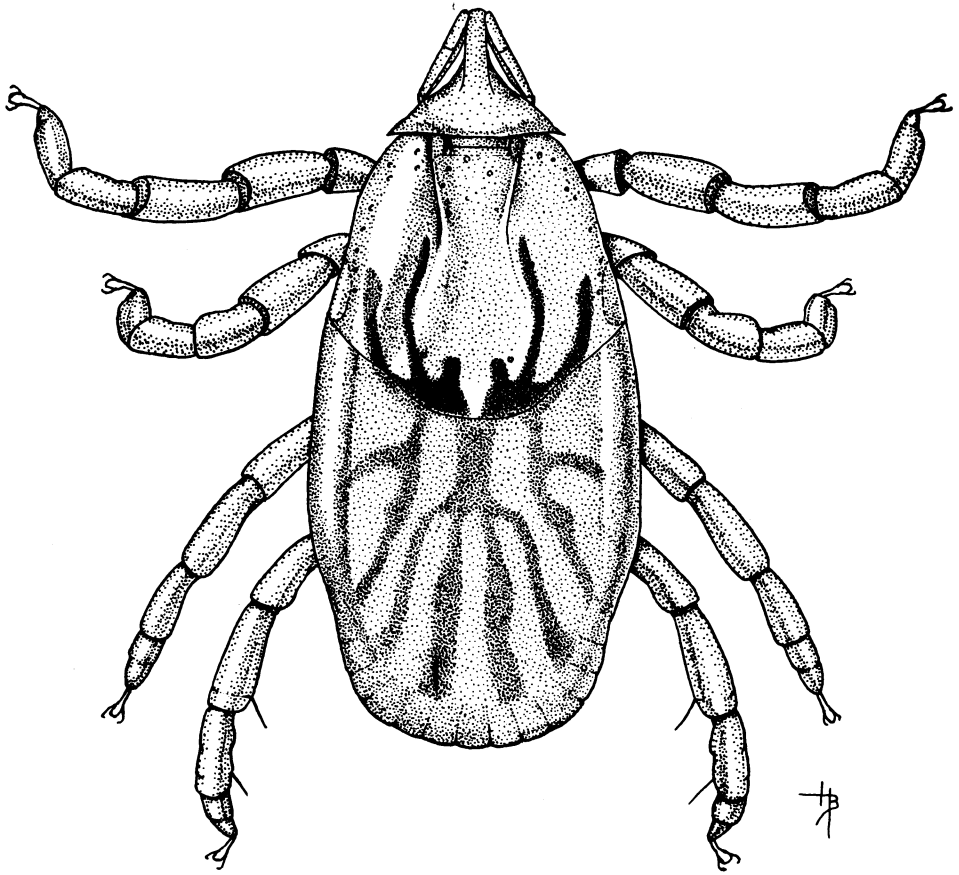
Spiracular Plate

Dorsal

FEMALE

Ventral

Dermacentor variabilis



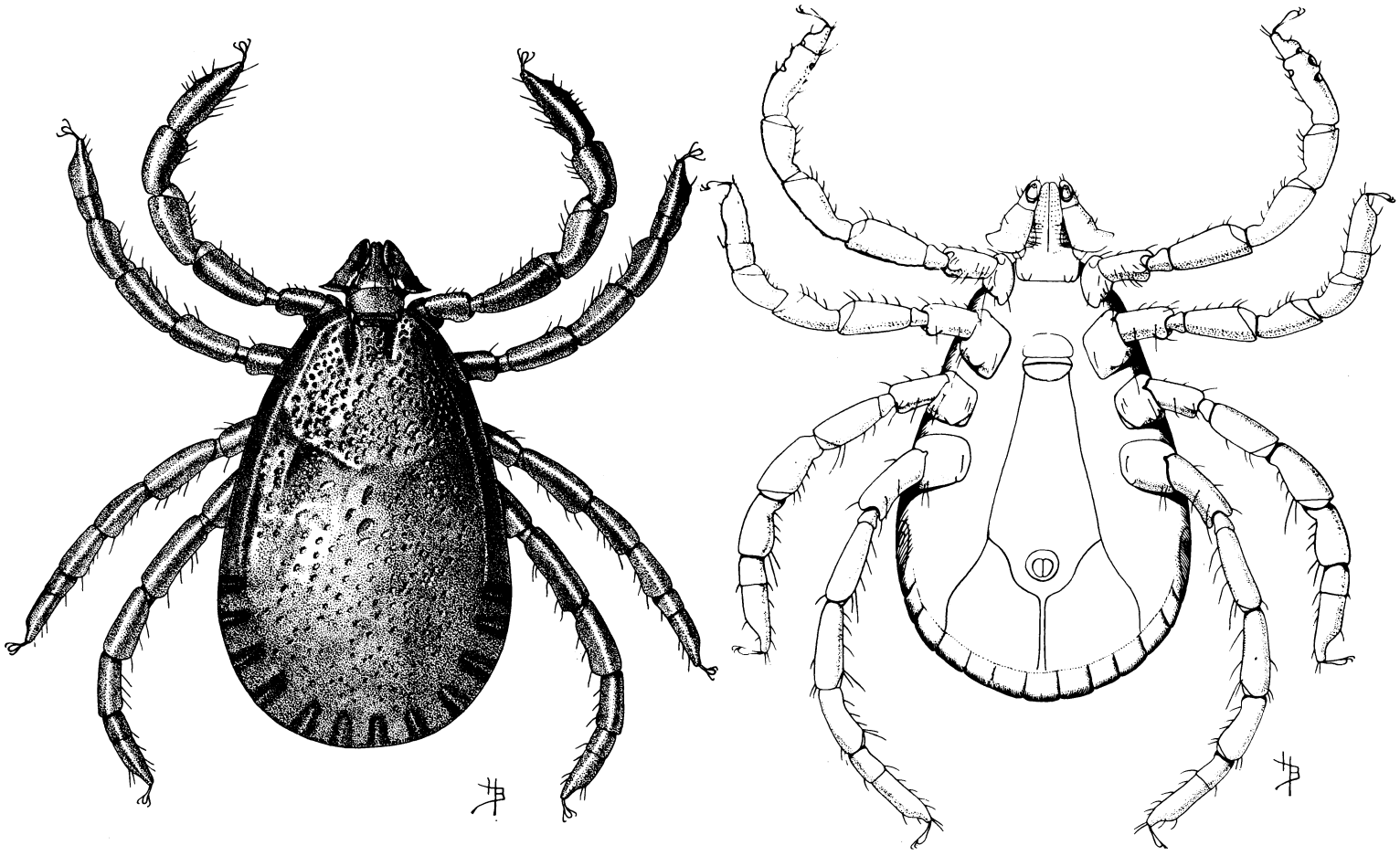
Spiracular Plate

Dorsal

NYMPH

Ventral

Dermacentor variabilis



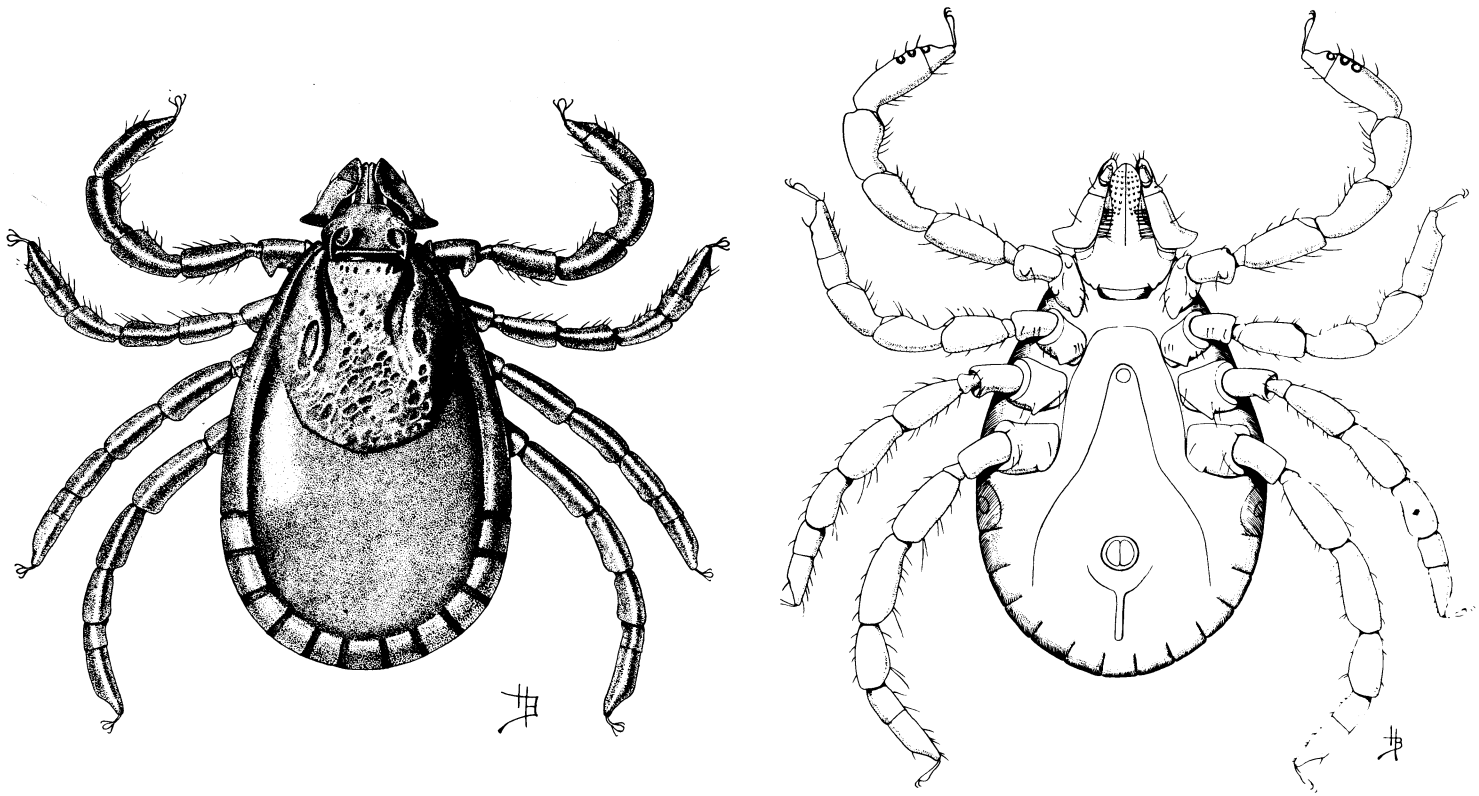
Dorsal

MALE

Ventral

Haemaphysalis leporispalustris

PLATE 42

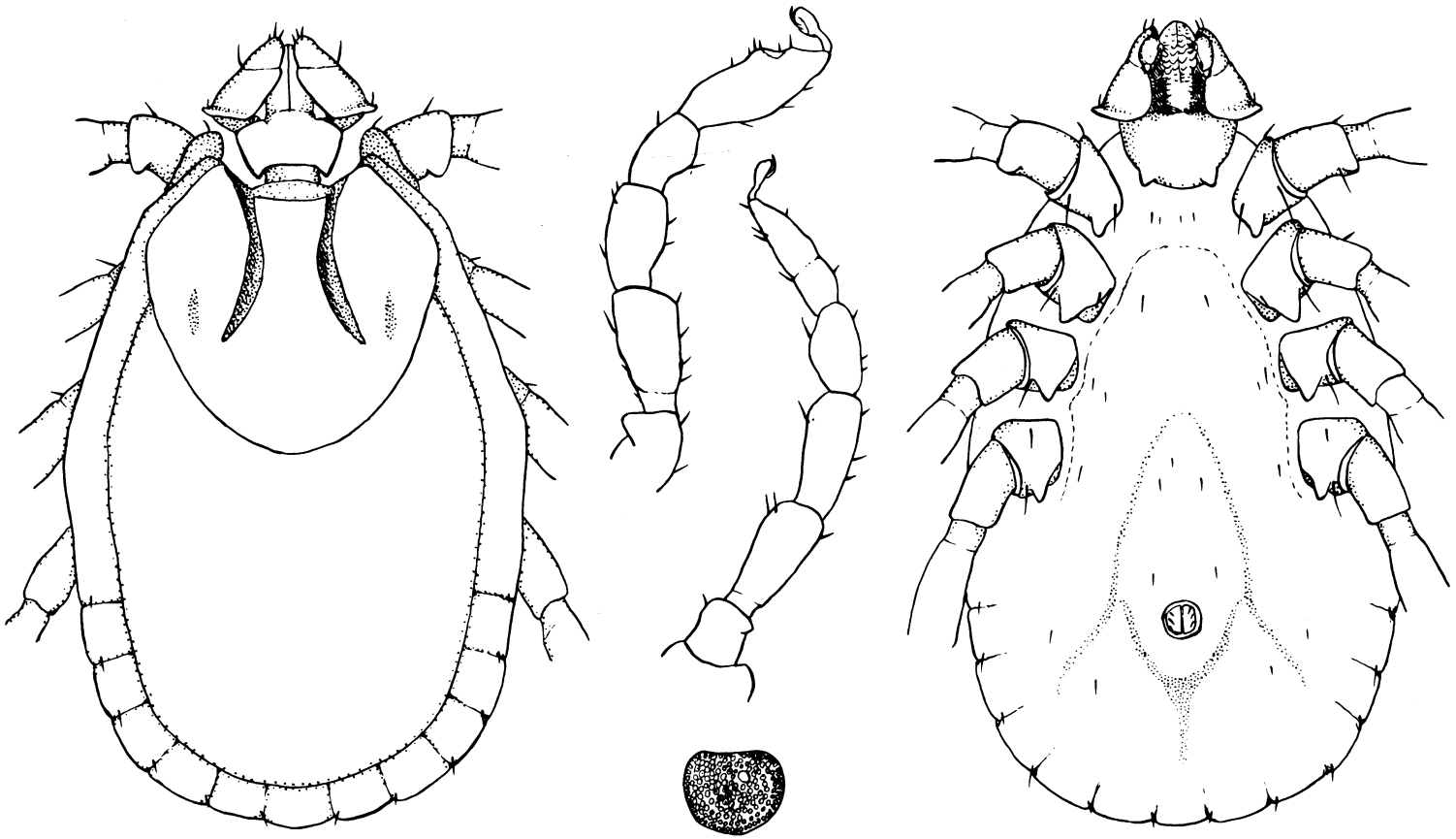


Dorsal

FEMALE

Ventral

Haemaphysalis leporispalustris

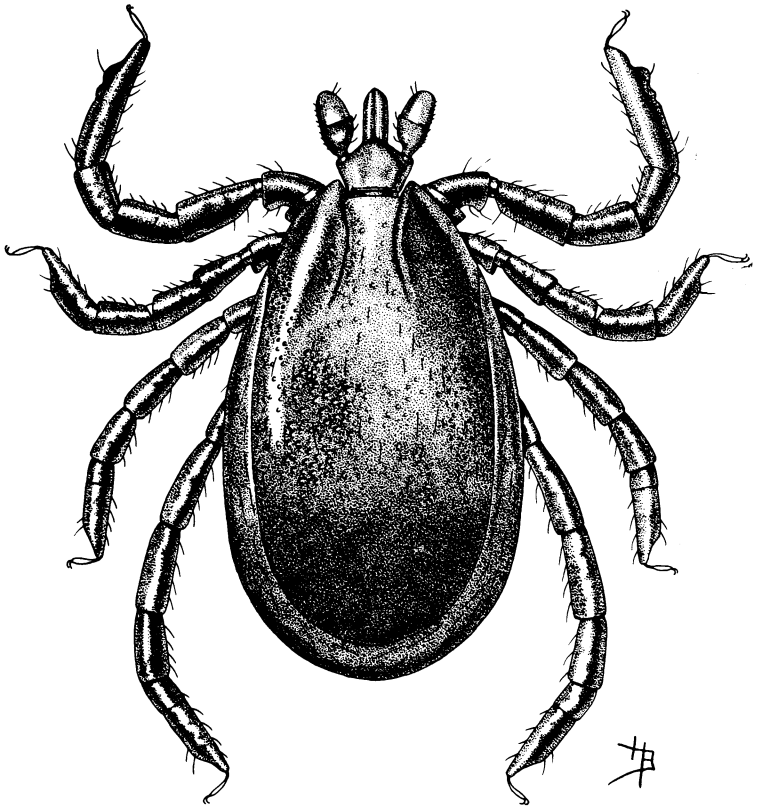


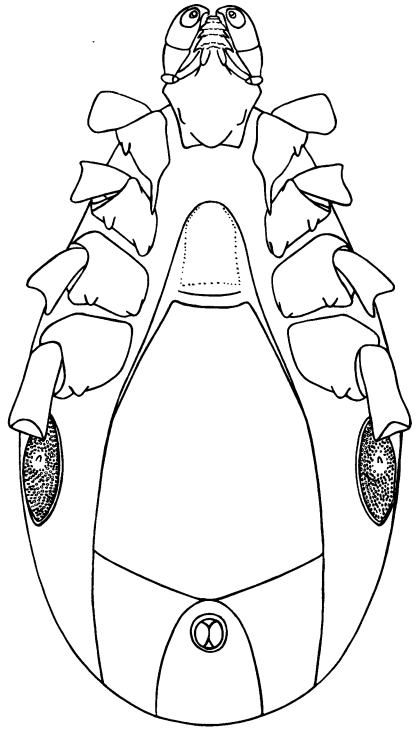
Dorsal

NYMPH

Ventral

Haemaphysalis leporispalustris



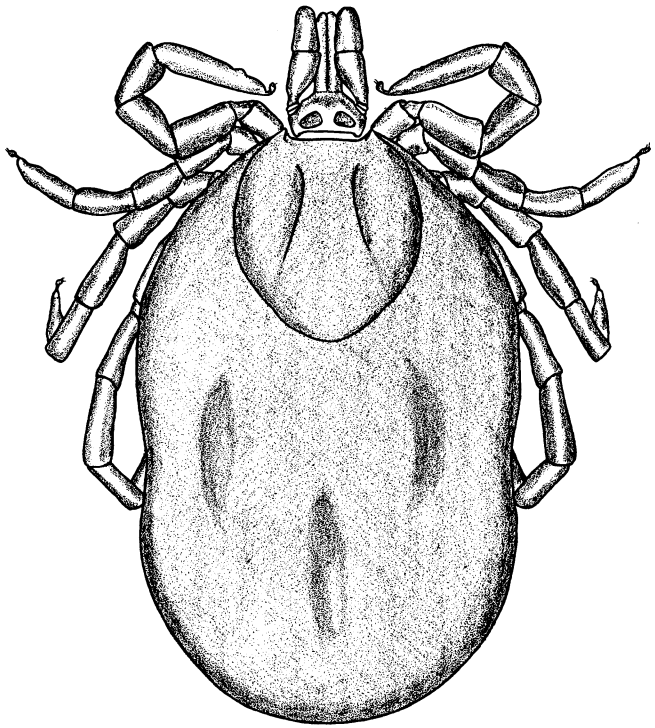


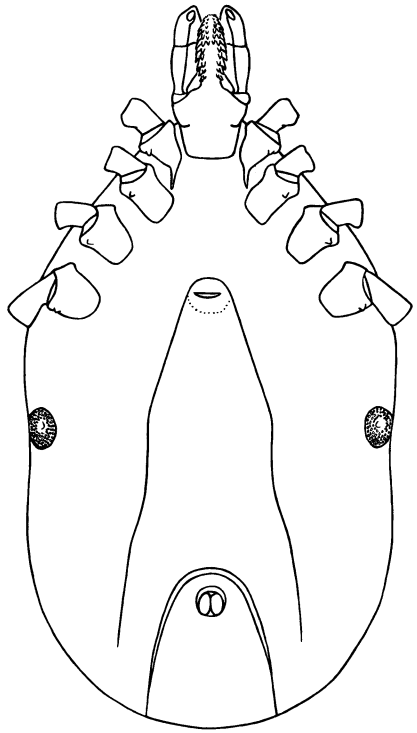
Dorsal

MALE

Ventral

Ixodes scapularis



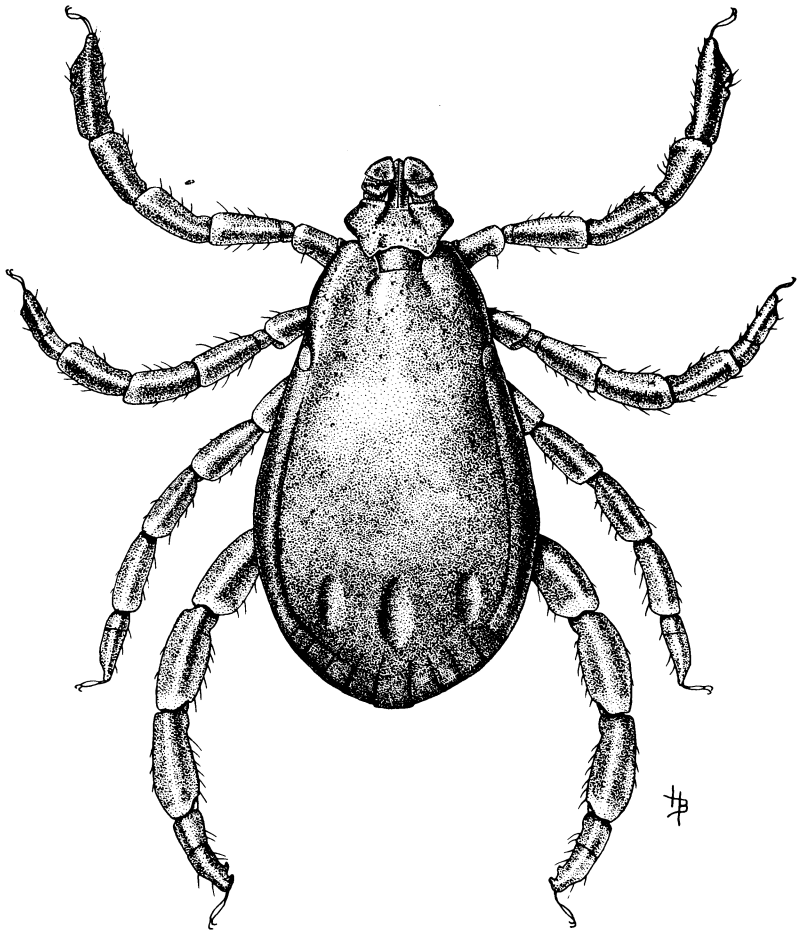


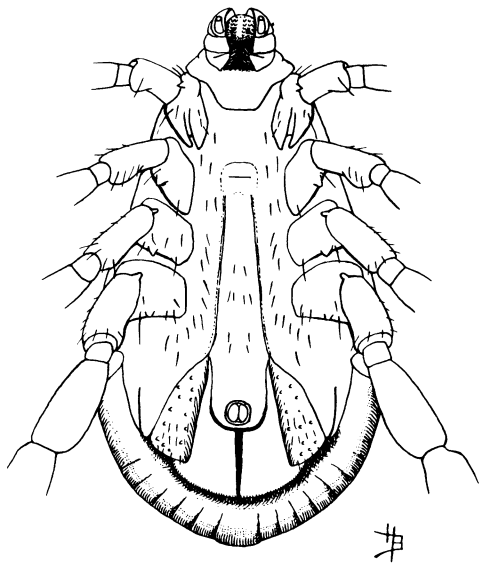
Dorsal

PARTIALLY ENGORGED FEMALE

Ventral

Ixodes scapularis



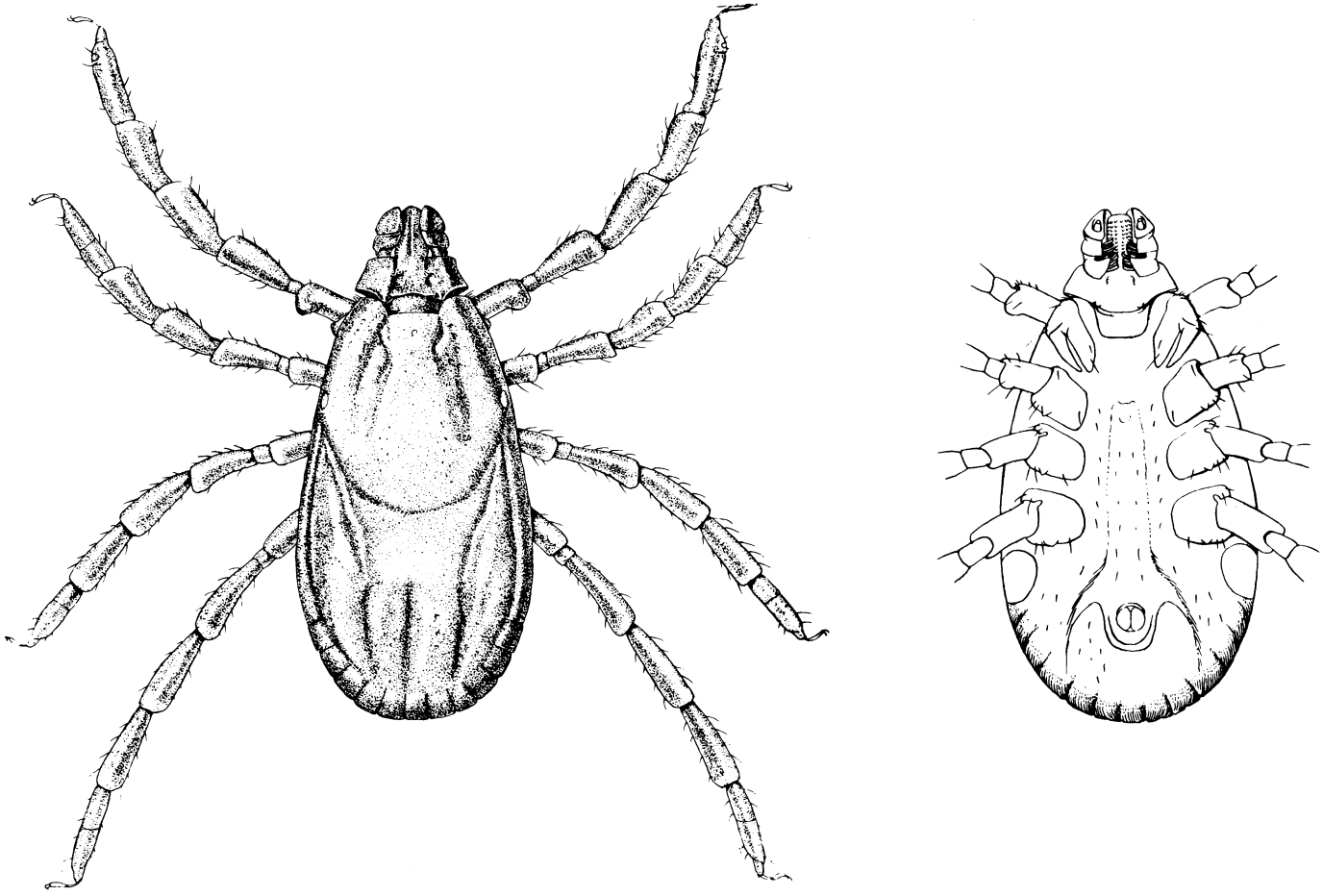


Dorsal

MALE

Ventral

Rhipicephalus sanguineus

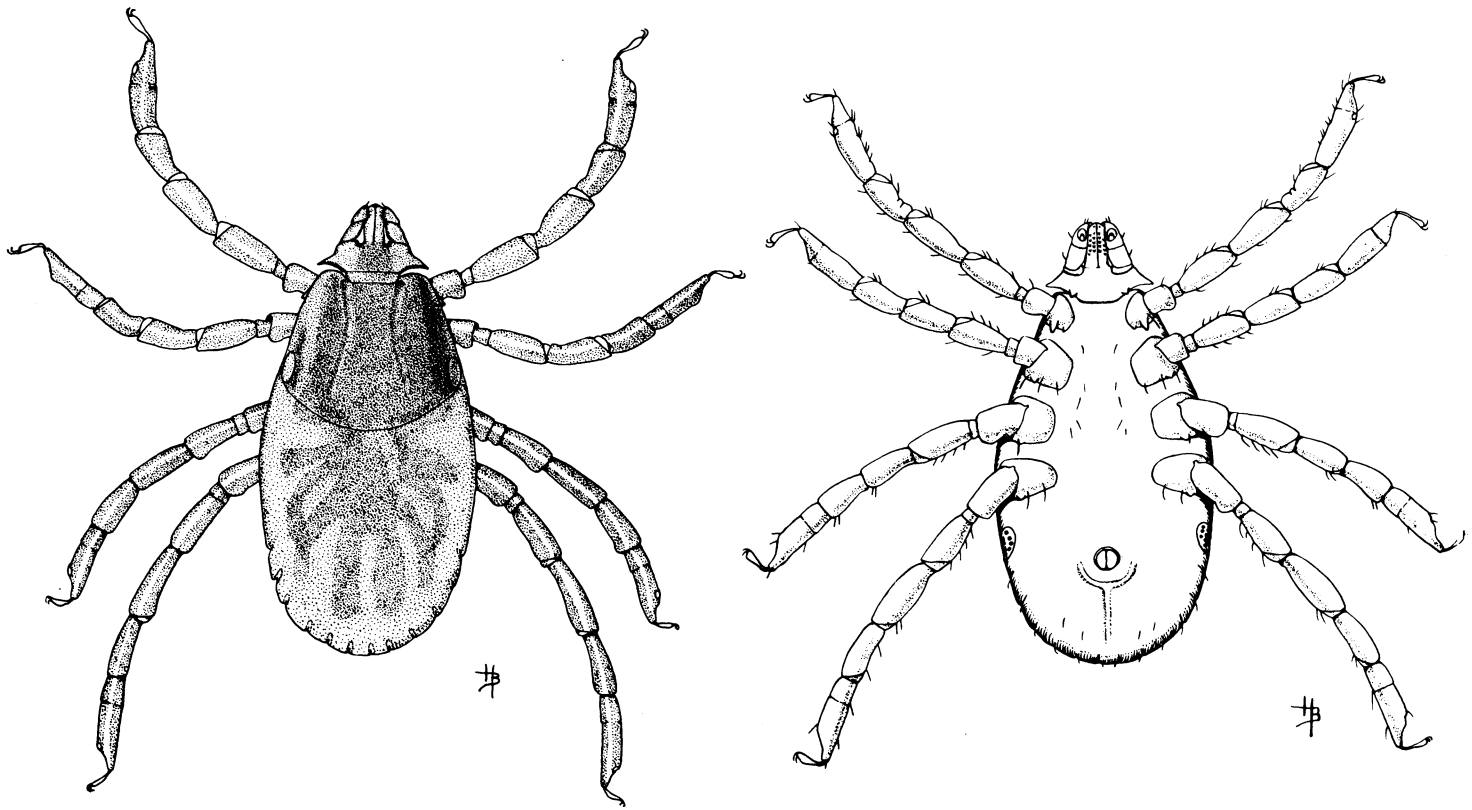


Dorsal

UNENGORGED FEMALE

Ventral

Rhipicephalus sanguineus



Dorsal

NYMPH

Ventral

Rhipicephalus sanguineus